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NUCLEAR SAFEGUARDS: A READER

REPORT

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LETTER OF SUBMITTAL

CONGRESSIONAL RESEARCH SERVICE,
THE LIBRARY OF CONGRESS,
Washington, D.C., May 1983.

Hon. MARILYN BOUQUARD,
Chairman, Subcommittee on Energy Research and Production, Committee on Science and Technology, U.S. House of Representatives, Washington, D.C.

DEAR MADAM CHAIRMAN: In response to your request of November 31, 1982, the Congressional Research Service has prepared the enclosed reader on nuclear safeguards. It was compiled and edited by CRS Senior Specialist, Dr. Warren H. Donnelly and his associate, Dr. Joseph F. Pilat, with assistance of Ms. Kristin Vajs, a CRS bibliographer. The selection is intended to illustrate evolving thought over the past several decades by agencies and their officials, supporters of safeguards, and those who have doubts about them.

We submit this compilation soon after the halfway date for the term of the Nuclear Non-Proliferation Treaty. In 1995, its members will have to decide whether or not to continue it with its unique provision that commits them not to acquire nuclear weapons and to accept international inspection (safeguards) by the International Atomic Energy Agency to verify their no-weapons pledges. The halfway mark was reached last September.

We hope you will find this reader useful.

Sincerely,

GILBERT GUDE, *Director.*

Enclosure.

DON FUQUA (Fla.), Chairman

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May 19, 1983

LETTER OF TRANSMITTAL

Hon. Don Fuqua, Chairman
House Committee on Science
and Technology
Washington, D.C. 20515

Dear Mr. Chairman:

I submit herewith a compendium of articles and other papers on nuclear safeguards which has been prepared at my request by the Congressional Research Service of the Library of Congress. This Subcommittee, as you know, has been actively involved in nuclear proliferation matters in general, and in nuclear safeguards research and development in particular. This research and development is an essential element in the effectiveness of the technological and institutional components of the safeguards system.

This Reader provides a broad sample of material from diverse sources on nuclear safeguards questions. It will be of considerable value to Members of Congress as well as the public wishing to obtain a detailed understanding of this subject. In view of the continuing attention which nuclear proliferation matters will receive during the 98th Congress, this Reader should serve as a valuable resource.

I request and recommend that the Reader be published by the Committee on Science and Technology and made available as a public document of this Committee.

Sincerely,

Marilyn Lloyd
MARILYN LLOYD, Chairman
Subcommittee on Energy Research
and Production

ML:Djs
Enclosure

NUCLEAR SAFEGUARDS: A READER

Committee Print
Prepared for the
Subcommittee on Energy Research and Production
Committee on Science and Technology
U.S. House of Representatives
Ninty-Eighth Congress
First Session

Warren H. Donnelly
Congressional Research Service
Environment and Natural Resources Policy Division
The Library of Congress
May 1982

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1974

W. Haefle. NPT safeguards. In Nuclear proliferation problems. Stockholm International Peace Research Institute. Cambridge, Mass. The MIT Press, 1974. pp. 142-154 285

J. Prawitz. Arguments for extended NPT safeguards. In Nuclear proliferation problems. pp. 158-167 298

B. Rainer and B. Sanders. The IAEA's NPT safeguards -- national control and international safeguards. In Nuclear proliferation problems. pp. 133-141 308

Mason Willrich and Theodore B. Taylor. Nuclear theft: risks and safeguards. Cambridge, Mass. Ballinger, 1974. pp. 121-133 and 167-169 317

1975

B. Sanders and R. Rometsch. Safeguards against use of nuclear materials for weapons. Nuclear engineering international, September 1975. pp. 862-685 333

Paul C. Szasz. The adequacy of international nuclear safeguards. Journal of international law and economics, vol. 10, August - December 1975. pp. 423-436 337

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Mason Willrich. Terrorists keep out! Bulletin of the atomic scientists, May 1975. pp. 12-16 369

1976

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U.S. Congress. Senate. Committee on Government Operations. Export Organization Act of 1976. Hearings. 94th Congress, 2d Session, January 19, 20, 29, 30 and March 9, 1976 Statement of J. Kenneth Fasick. Director, International Division, U.S. General Accounting Office. pp. 537-541 387

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U.S. Congress. House. Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment. Safeguards in the domestic nuclear industry. A report. 94th Congress, 2d session, August 1976....................................... 421

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Ted Greenwood, Harold A. Feiveson and Theodore B. Taylor. Principles for effective safeguards. In their Nuclear proliferation. Motivations, capabilities and strategies for control. New York. McGraw-Hill Book Company, 1977. pp. 155-158.. 443

Nuclear power issues and choices. Report of the Nuclear Energy Policy Study Group. Cambridge, Mass. Ballinger, 1977. pp. 292-293.. 447

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1978

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Leonard Weiss. Nuclear safeguards: a Congressional perspective. Bulletin of the atomic scientists, March 1978. pp. 27-33 498

U.S. Nuclear Regulatory Commission. Safeguarding a domestic mixed oxide industry against a hypothetical subnational threat. Executive summary, May 1978 505

The Carter Administration's response to questions on IAEA safeguards. In U.S. Congress. Senate. Committee on Foreign Relations. IAEA safeguard agreement. Hearing. 96th Congress, 1st session, June 22, 1979. pp. 9, 10 523

1979

David Fischer. International safeguards 1979, International Consultative Group on Nuclear Energy. New York. The Rockefeller Foundation, September 1979. pp. 25-35 525

Ryukichi Imai. Safeguards--a new approach. Nuclear engineering international, April 1979. pp. 53-56 537

IAEA contribution to INFCE. The present status of IAEA safeguards on nuclear fuel cycle facilities. Vienna. International Atomic Energy Agency, February 1979. pp. 1-15 541

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PART I: PURPOSE AND BACKGROUND

Purpose

At the request of Representative Marilyn Bouquard, Chairman of the Subcommittee on Energy Research and Production of the Committee on Science and Technology, the Congressional Research Service has prepared this reader on nuclear safeguards. Its selections include excerpts from public laws, treaties and official reports, together with selected statements, articles and other writings. The viewpoints represented range from those strongly supportive of safeguards to those dubious of their reliability and effectiveness.

To provide background, the reader begins with a CRS report on the IAEA and the 1982 update and summary of the report on Nuclear Proliferation and Safeguards prepared for Congress by the Office of Technology Assessment. Then come the selections, which are divided into two parts. The first includes thirteen reference documents. The second is a chronological selection of official reports and statements, articles and other writings. The full text is given for some and excerpts for others. Forty-six are generally supportive of safe guards, and thirty-six others express doubts. Seven take both views. The chronological order gives a sense of how thinking about safeguards has evolved. The period covered is from 1967 to 1982. A supplementary CRS bibliography appears in Appendix A.

Background

A few introductory notes are in order to define and briefly describe nuclear safeguards and to indicate their place in the international non-proliferation regime. The latter refers to the scheme of treaties, voluntary international agreements, international and national organizations that collectively are intended to avoid any further spread or proliferation of nuclear weapons associated with civil nuclear power.

The nuclear materials of special concern for safeguards are uranium-235, uranium-233 and plutonium because they can be used to make atom bombs. Of these, U-233 and plutonium do not exist in nature. These nuclear materials are made by exposing thorium and uranium-238, respectively, to neutrons -- usually in a nuclear reactor. The U-233 and plutonium are then recovered by chopping up the irradiated thorium or uranium, dissolving it in strong acid, and chemically separating the desired materials. This is called reprocessing. The Department of Energy has two large reprocessing plants to provide plutonium for its manufacture of nuclear weapons. While the United States has no commercial reprocessing plants in operation, there are such plants in England and in France, several small ones in India, a pilot reprocessing plant working in Japan, one nearing completion in Argentina, and one under construction in Pakistan. The Soviet Union also has reprocessing capability.

While U-235 exists in nature, it is greatly diluted with U-238 in a ratio of 7 atoms of U-235 for every 1000 atoms of uranium. To be useful for weapons, the U-235 content of uranium has to be concentrated, or "enriched", to 90 percent or better. Enrichment is now provided through two processes, gaseous diffusion and centrifugal separation. The former is used at DOE's three existing enrichment plants and in foreign plants in England, France and the Soviet

Union. The latter will be used for DOE's new enrichment facility and is used in United Kingdom and Netherlands. West Germany, Australia and Japan are planning enrichment plants using the centrifuge process, and Pakistan is trying to build one.

As used in today's international context, the term "nuclear safeguards" refers collectively to a combination of record keeping to account for nuclear materials, verification of these accounts by international inspection, and other measures to assure against diversion (containment and surveillance). Most of the inspections made by the International Atomic Energy Agency (IAEA) are in states which have no nuclear weapons and have pledged under the Treaty on Non-Proliferation of Nuclear Weapons (NPT) or the Treaty of Tlatelolco not to make them. IAEA inspection and associated measures are intended to verify there has been no diversion of nuclear materials to make nuclear weapons or explosives. The IAEA safeguards agreements with NPT states also require these safeguarded states to establish and maintain records to account for nuclear materials received, produced, used, exported and otherwise disposed of.

When the United States began to export nuclear materials and items, particularly after the Atomic Energy Act of 1954 gave a major impetus to private use of this new energy source, the Atomic Energy Commission initially sent its own inspectors overseas to verify that U.S. nuclear exports were not used improperly. The international safeguards mentioned by President Eisenhower in his Atoms-for-Peace speech to the United Nations in 1953 did not begin to come of age until after the IAEA was established in 1957 by an international statute, to which the U.S. Senate gave its consent. Even then, international inspection moved slowly, although the United States promoted this idea by requiring its nuclear partners to accept inspection by the IAEA instead of by the AEC.

International safeguards received a major impetus with the NPT, which took effect in 1970. The NPT committed its non-weapons member states to negotiate safeguards agreements with the Agency to cover all of their nuclear activities. All member states also agreed to require IAEA safeguards for any of their nuclear exports. The United States and the Soviet Union are considered the cofounders of the NPT and, in particular, of its safeguards provisions. Today international safeguards are generally viewed, although with some exceptions, as able to verify that significant quantities of nuclear materials have not been diverted from conventional nuclear fuel cycles.

There are, however, two substantial problems: one is political; the other is technical.

One political problem is that certain states will not ratify the NPT or the Treaty of Tlatelolco, so that some of their indigenous nuclear facilities and nuclear materials may not be subject to international inspection. These states include Argentina, Brazil, Israel, India, Pakistan and South Africa. Another is the grudging financial support for IAEA safeguards operation. A third is the unhappy intrusion of external political controversies into the Agency with dangers that the effectiveness of its safeguards system may be damaged by this politicization.

The technical problem is the ability of IAEA safeguards to assure detection of significant amounts of plutonium that might be diverted or stolen from civil uses, should this special nuclear material come into commercial production and use in the United States or abroad. The central technical facts are that somewhat more than six kilograms of plutonium in the hands of an experienced weapons designer could be made into a nuclear explosive, and that commercial use of plutonium would involve handling this material in bulk form by the ton, which would create uncertainties about possible small diversions.

The effect of these problems is visible in recent criticisms of IAEA safeguards. Some critics argue that present record keeping, inspection, sampling and analysis are neither sensitive nor accurate enough to provide timely warning of systematic small diversions, or to assure that no such diversions have occurred. Others question the social costs of a safeguards system adequate to cope with plutonium fuel cycles. Some argue further that even if safeguards could reliably detect small diversions and sound an alarm, present arrangements for world counteraction are ineffectual. Some warn that terrorists, or criminal or extremist bodies might be able to steal plutonium for purpose of blackmail or violence.

On the other hand, most officials, national and international, hold that safeguards can be upgraded enough to permit commercial use of plutonium within reasonable risks.

The Subcommittee on Energy Research and Production held hearings in August 1982 on research and development for safeguards. Several of the statements from this hearing appear in the reader.

Today, after almost four decades of nuclear energy for military and civil uses, the argument still goes on whether nuclear materials can be produced and used without unacceptable risks of spreading nuclear weapons. That only five states now have nuclear arsenals is a good sign. However, in some quarters there are doubts that safeguards can be upgraded enough to permit widespread use of materials that, if diverted, could be directly used to make nuclear explosives.

Background material

The background part of the reader includes three items. One is a fact sheet on the Agency and its safeguards prepared by the Congressional Research Service. Second is a lecture on the historical and political framework of safeguards by Gerald F. Tape, President of Associated Universities Inc., and a former U.S. representative to the IAEA, given in 1980. Third is a similar lecture given in 1982 by John P. Boright of the State Department. The differences in viewpoint of the two lectures provide interesting contrast.

PART II: SOME BASIC DOCUMENTS

Part II includes fundamental references, beginning with excerpts from three landmark reports of 1946: the report of the Board of Consultants to the State Department on the international control of atomic energy (The Acheson-Lilienthal report), the U.S. proposal for international control of atomic energy made to the U.N. Atomic Energy Commission (The Baruch plan), and the first report of the U.N. Atomic Energy Commission. Other documents include two U.S. reports on the International Atomic Energy Agency, its statute, the International Atomic Energy Agency Participation Act of 1957, excerpts from the Treaty on the Non-Proliferation of Nuclear Weapons (the NPT), excerpts from the Treaty for the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco), excerpts from the Nuclear Non-Proliferation Act of 1978, an IAEA information circular on the structure and contents of NPT type safeguards agreements, and a recent IAEA booklet on its safeguards.

PART III: SELECTED READINGS ON NUCLEAR SAFEGUARDS: 1967-1982

The ninety selected readings in Part III on nuclear safeguards cover the years 1967-1982. During this time, the importance of safeguards and interest in their capabilities and performance has gradually increased. Today there are two distinctly different views about safeguards. One holds that the combination of national and international inspection of detailed materials accounts and verification of inventories, plus measures to restrict access to nuclear materials (containment) and to observe and monitor their handling and movements (surveillance) can provide reasonable assurance that thefts or diversions will be detected. The existence of this capability is expected to deter governments of non-nuclear weapons states from trying to divert nuclear materials from their commercial nuclear power operations for the manufacture of nuclear weapons.

The other view holds that fundamental limitations of measurements and analyses, of containment and surveillance, and of national and international organization and systems for safeguards mean that some weapons usable materials might be diverted or stolen and that its absence might go unnoticed, or be discovered too late for effective counteraction. Moreover, from this viewpoint the IAEA lacks police powers to enforce its requirements, is not permitted to look for clandestine facilities that may be producing weapons usable materials, and is unlikely ever to get all of the resources it needs. So safeguards are seen as providing a sense of false security and cannot be relied upon to give absolute assurance that all nuclear materials, especially highly enriched uranium and plutonium, are accounted for at all times, or that there will be timely warning of theft of diversion.

The divergence between the two viewpoints becomes greater for the safeguarding of the commercial production and use of plutonium for nuclear fuel. Much of the difference arises from differing perceptions of the ability of national and international systems to safeguard reprocessing plants and other places where the separated plutonium might be stored, processed or fabricated.

The selected readings are arranged in chronological order. Where several items are included for a year, these are arranged in alphabetical order. The selections include excerpts from larger reports and other writings, and from statements of officials and others to committees of the Congress. The selections illustrate the wide range in thinking about nuclear safeguards and their ability to assure that civil nuclear power can be kept well separated from nuclear weaponry. They carry implications for the future course of the development and use of this new energy source of the twentieth century. Table I lists the selected readings and indicates whether they are generally supportive or questioning, or both.

TABLE I: LIST OF SELECTED READINGS INDICATING WHETHER THEY ARE SUPPORTIVE OR QUESTIONING OF SAFEGUARDS, AND THEIR DATES

ITEM	SUPPORTIVE	QUESTIONING	YEAR
Ad Hoc Advisory Panel on Safeguarding Special Nuclear Material. Report to the Atomic Energy Commission (The Lumb report). Excerpt.	X		67
Barton.			
The societal impact of safeguards.		X	76
Blix.			
Statement to the IAEA Board of Governors.	X		82
Bradford, Commissioner.			
Testimony to House Foreign Affairs Committee.		X	82
Carrea.			
Views from Argentina.	X		80
Caudle.			
Statement to House Committee on Foreign Affairs.	X		82
Cranston, Senator.			
Statement to Senate Foreign Relations Committee, June.		X	81
Statement to Senate Foreign Relations Committee, December.		X	81
Donnelly.			
Speculations on alternatives to IAEA safeguards.	X	X	82
Eklund.			
Safeguarding plutonium.	X		80
Statement to the IAEA Board of Governors.	X		81
Fasick.			
Statement to Senate Governmental Affairs Committee.			
Fischer.			
International safeguards.	X		79
Safeguards under the NPT.	X		80
Safeguards and nonproliferation.	X		81
Gilinsky, Commissioner.			
Safeguarding the fuel cycle.		X	76
Statement to House Interior and Insular Affairs Committee.		X	79
International discipline over uses of nuclear energy.		X	78
Statement to Senate Foreign Relations Committee.		X	81
More nuclear weapon states?		X	82
Goldschmidt.			
The Atomic Complex. Excerpt: Safeguarding nuclear energy.		X	82
Glenn, Senator.			
Statement to Senate Governmental Affairs Committee.		X	81
Statement to Senate Foreign Relations Committee.		X	81
Greenwood, Feiveson and Taylor.			
Nuclear proliferation, motivation, capabilities and strategies for control. Excerpts.		X	77
Grumm.			
IAEA safeguards, status and prospects.	X		81
Comments on Morgan's criticisms.	X		82
Potential and limitations of international safeguards.	X		82
Haefle.			
NPT safeguards.	X		74
Hart, Senator.			
Statement to the Senate Committee on Foreign Relations.		X	81
Statement to the House Committee of Foreign Affairs.		X	82
Hendrie, NRC chairman.			
Statement to the House Committee on Interior and Insular Affairs.	X		79
Herron.			
A lawyer's view of safeguards and non-proliferation.	X		82
Houck.			
Statement to House Committee on Foreign Affairs.	X		81
Imai.			
Safeguards, a new approach.	X		79

TABLE I: LIST OF SELECTED READINGS INDICATING WHETHER THEY ARE SUPPORTIVE OR QUESTIONING OF SAFEGUARDS, AND THEIR DATES (Continued)

ITEM	SUPPORTIVE	QUESTIONING	YEAR
IAEA.			
IAEA contributions to INFCE.	X		79
IAEA safeguards in 1981.	X		82
INFCE.			
Summary Volume. Excerpt.	X		80
Kennedy, Ambassador.			
Statement to Senate Committee on Foreign Relations.	X		81
Statement to the House Committee on Foreign Affairs.	X		82
Kissinger.			
Statement to the Senate Committee on Government Operations. Excerpt.	X		76
Kouts.			
Statement to the Senate Committee on Foreign Relations.	X		81
Kratzer.			
Safeguards against nuclear proliferation.	X		67
Prospective trends in international safeguards.	X		80
Historical overview of international safeguards.	X		82
Leventhal.			
Statement to the House Committee on Foreign Affairs.		X	82
Lovins and Lovins.			
Energy/War. Excerpt.		X	80
Markey, Representative.			
Nuclear peril. Excerpt.		X	82
Moglewer.			
IAEA safeguards and non-proliferation.	X	X	81
Morgan.			
Statement to the Senate Committee on Foreign Relations.		X	81
Muntzing.			
Statement to the House Committee on Science and Technology (for the American Nuclear Society).	X		82
Nakicenovic.			
Comments on IAEA safeguards.	X	X	81
The Nuclear Energy Policy Study Group.			
Nuclear power: issues and choices. Excerpts.		X	77
Palladino, NRC chairman.			
Statement and letter to the House Committee on Foreign Affairs.		X	82
Percy, Senator.			
Statement to the Senate Committee on Foreign Relations.	X		81
Petit.			
A view from France.	X		80
Prawitz.			
Arguments for extended NPT.	X	X	74
Pringle.			
Nuclear unsafeguards.		X	81
Rainer and Sanders.			
The IAEA's NPT safeguards -- national control and international safeguards.	X		74
Richter.			
Statement to the House Committee on Foreign Affairs.		X	81
Statement to the Senate Committee on Foreign Relations.		X	81
Rometsch.			
International safeguards objectives, status and unresolved issues. The IAEA view.	X		77
Safeguards 1975-1985.	X		76

TABLE II: LIST OF SELECTED READINGS INDICATING WHETHER HEY ARE SUPPORTIVE OR QUESTIONING OF SAFEGUARDS, AND THEIR DATES (Continued)

ITEM	SUPPORTIVE	QUESTIONING	YEAR
Rostow. Statement to House Foreign Affiars Committee.	X	X	82
Sanders and Rometsch. Safeguards against use of nuclear materials for weapons.	X		75
Scheinman. Statement to the House Committee on Foreign Affairs.	X	X	82
Scherr. Statement to the Senate Committee on Governmental Affairs. Excerpt.		X	81
Schleicher. Euratom: non-proliferation and safeguards in the 1980's.	X		80
Sessoms. Statement to the House Committee on Science and Technology. Excerpts.	X		82
Shea. Statement to the Senate Committee on Foreign Relations.	X		81
Smythe. The need for international safeguards.	X		73
Symington, Senator. The nuclear safeguards delusion.		X	75
Szasz. The adequacy of international nuclear safeguards.	X		75
U.S. Congress. House Committee on Interior and Insular Affairs Subcommittee on Energy and the Environment. Safeguards in the domestic nuclear industry, a report.		X	76
U.S. Congress. Office of Technology Assessment.			
Nuclear proliferation and safeguards.	X	X	77
Updated summary. Excerpts.	X	X	82
U.S. Department of State.			
Response to questions on the IAEA and its safeguards (to the Senate Committee on Foreign Relations).	X		79
Comment on an NRC letter (to the Senate Committee on Foreign Relations).	X		81
U.S. General Accounting Office.			
Report on the role of the IAEA in safeguarding nuclear materials.	X	X	75
Evaluation of the Administration's proposed nuclear non-proliferation strategy. Excerpt.		X	77
The Nuclear Non-Proliferation Act of 1978 should be selectively modified. Excerpt.	X	X	81
Statement to the Senate Committee on Foreign Relations (Finley).	X	X	81
U.S. Nuclear Regulatory Commission.			
Safeguarding a domestic mixed oxide industry against a hypothetical subnational threat. (GESMO) NUREG 0414, Executive Summary.	N/A	N/A	78
Prepared statement to the House Committee on Science and technology.	X		82
Weiss. Nuclear safeguards: A congressional perspective.		X	78
Weissman & Krasney. The Islamic Bomb. Excerpt.		X	81
Willrich & Taylor. Nuclear theft: risks and safeguards. Excerpts.		X	74
Willrich. Terrorists keep out.		X	75
Wohlstetter. Moving toward life in a nuclear armed crowd. Excerpt.		X	76

PART I

PURPOSE AND BACKGROUND

Report No. 82-86 S

THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) AND ITS SAFEGUARDS: A FACT SHEET

by
Joseph F. Pilat
Office of Senior Specialists

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ABSTRACT

A compilation of selected facts about the International Atomic Energy Agency, its purposes, organization, functions, funding and problems with attention to the authority for and limitations of its international inspection (safeguards) function.

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INTRODUCTION

The International Atomic Energy Agency (IAEA) is largely the creation of an American proposal of President Eisenhower in 1953. Established in 1957, one of its principal functions is to inspect nuclear activities in subscribing states to verify that for some states these are not being used for military purposes, and for other states that these are not used to make nuclear weapons. There are called safeguards. Strong IAEA safeguards are central to U.S. policy to prevent the further spread, or proliferation of nuclear weapons.

Over recent years there have been some doubts about the adequacy of IAEA safeguards. These doubts were strengthened in the aftermath of Israel's bombing and destruction of Iraq's powerful research reactor on June 7, 1981. Many Members of Congress have since then expressed their concern about IAEA safeguards, especially their adequacy for possible commercial production and use of plutonium -- a material usable for nuclear explosives -- as a nuclear fuel. Legislation have been introduced to limit or even cutoff U.S. nuclear exports until IAEA safeguards could be improved.

This fact sheet was prepared to provide summary background on the Agency and its safeguards function. It includes information on the purposes, organization, functions, funding and problems of the Agency, and on the authority for and limitations of its safeguards function.

FACT SHEET

What Is the IAEA?

Established on July 29, 1957, by an international statute, the IAEA is a relatively autonomous international organization affiliated with the United Nations, although it is not under U.N. direction or control. Its headquarters are located in Vienna, Austria.

What Is its Purpose?

Article II of its Statute states that the objective of the IAEA is to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purposes."

What Does It Do?

The IAEA has two main functions: to promote peaceful uses of atomic energy, including technical assistance; and to apply international safeguards when requested. In addition, the IAEA establishes international standards of safety for nuclear energy.

How Is It Organized?

The IAEA has three principle parts:

The General Conference, with representatives of all member states, meets annually to debate general policy and approve programs and budgets, and elects members of the Board of Governors;

The Board, with representatives from 34 nations, is the executive organ of the Agency. It meets about 4 times a year, and considers policy, recommends budgets, appoints a Director-General, approves states for membership; and Secretariat, headed by the Director-General, which administers and implements the Agency's program. The Secretariat is divided into five departments -- Administration, Research and Isotopes, Safeguards, Technical Assistance and Publications, and Technical Operations -- each headed by a Deputy Director-General. The Director-General is advised on scientific and technical matters by a Scientific Advisory Committee of distinguished scientists, whose appointments are for three-year terms and who represent all fields of nuclear science. The Standing Advisory Group on Safeguards Implementation (SAGSI) provides advice on technical aspects of safeguards.

How Is the IAEA Funded?

The IAEA is funded through regular and voluntary contributions from member states, with some income derived from sales of publications and charges for technical assistance. In 1980, the regular budget of the IAEA was $80,643,000, of which $19,363,224 was from the U.S. An estimated $13,829,800, excluding contributions in kind, was voluntarily contributed in 1980. Of this sum, the U.S. contributed $2,451,000.

What Is the Size of the Staff?

At the end of 1980, the Secretariat had a total staff of 1597. Of these 577 were in the professional and higher categories; 865 in the General Service cetageory; and 155 in the maintenance and operations category.

Who Are the Key Officials?

-- Director-General, Hans Blix, Sweden;
-- Deputy Director-General, Department of Administration,
   Nelson Sievering, United States of America;

- -- Director, Division of External Relations, Department of Christoher Herzig, United Kingdom;
- -- Director, Division of Public Information, Department of Administration, Georges Delcoigne, Belgium;
- -- Deputy Director-General, Department of Safeguards, Hans Gruemm, Austria;
- -- Director, Division of Development and Technical Support, Department of Safeguards, Adolf von Baeckmann, Federal Republic of Germany;
- -- Director, Division of Safeguards Information Treatment, Department of Safeguards, Lev Issaev, U.S.S.R.;
- -- Director, Division of Operations (A), Department of Safeguards, Frantisek Klik, Czechoslovakia;
- -- Director, Division of Operations (B), Department of Safeguards, Tohru Haginoya, Japan;
- -- Deputy Director-General, Department of Technical Cooperation, Carlos Velez, Mexico;
- -- Deputy Director-General, Department of Technical Operations, Boris Semenov, U.S.S.R.; and
- -- Deputy Director General, Department of Research and Isotopes, Maurizio Zifferero, Italy.

What Are IAEA Safeguards?

The safeguards administered by the IAEA are a system of recordkeeping, audits, and inspections with national and international components intended to deter the diversion of nuclear materials to military uses and particularly to nuclear weapons or other nuclear explosive devices by imposing risks of discovery and counteraction.

IAEA safeguards for NPT states differ from those for non-NPT states. The purpose of the NPT safeguards is to ensure "the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices... and deterrence of such diversion by risk of early detection." Non-NPT safeguards seek to ensure that nuclear assistance provided by or at the request of the Agency is not used to further any military purpose. NPT safeguards apply to all nuclear facilities and materials for peaceful purposes in any NPT state, with the exception of the nuclear weapons states. Non-NPT safeguards apply only to nuclear facilities and materials that are placed under safeguards by an agreement between the possessing state and the Agency. NPT safeguards focus upon materials throughout the state and emphasize sampling, measurement, and statistical analysis rather than total inspection. They require a national system of accounting for and control of nuclear materials, which the Agency audits and inspects to verify its findings of the national system. Non-NPT safeguards require only those records and reports as agreed upon between the supplier state, the receiving state, and the Agency.

What are the International Bases of IAEA Safeguards?

IAEA Statutes. -- Article III, 5 of the Statute of the IAEA authorizes it:

> To establish and administer safeguards and to apply safeguards upon request to any bilateral or multilateral arrangement or at the request of a State.

Article XII of the Statute provides:

> With respect to any Agency project, or other arrangement where the Agency is requested by the parties concerned to supply safeguards, the Agency shall have the following rights and responsibilities to the extent relevant to the project or arrangement:
>
> 1. To examine the design of specialized equipment and facilities, including nuclear reactors, and to approve it only from the viewpoint of assuring that it will not further any military purposes, that it complies with applicable health and safety standards, and that it will permit effective application of safeguards. . .
>
> 2. To require the observance of any health and safety measures prescrbed by the Agency;
>
> 3. To require the maintenance and production of operating records to assist in ensuring accountability for source and special fissionable materials used or produced in the project or arrangement;
>
> 4. To call for and receive progress reports;
>
> 5. To approve the means to be used for the chemical processing of irradiated materials solely to ensure that this chemical processing will not lend itself to diversion of materials for military purposes and will comply with applicable health and safety standards. . .

> 6. To send into the territory of the recipient state or states inspectors, designated by the Agency, after consultation with the state or states concerned, who shall have access at all times to all places and data and to any person who by reason of his occupation deals with materials, equipment or facilities which are required by this statute to be safeguarded, as necessary to account for source and special fissionable materials supplied and fissionable products and to determine whether there is compliance with the undertaking against use in furtherance of any military purposes. . . Inspectors designated by the Agency shall be accompanied by representatives of the authorities of the state concerned, if that state so requests, provided that the inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

Treaty on the non-proliferation of nuclear weapons. -- Article III of the NPT states:

> 1. Each non-nuclear weapon State Party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agency's safeguards system, for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. Procedures for the safeguards required by this article shall be followed with respect to source or special fissionable material whether it is being produced, processed or used in any principal nuclear facility or it outside any such facility. The safeguards required by this article shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.
>
> 2. Each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this article.
>
> 3. The safeguards required by this article shall be implemented in a manner designed to comply with article IV of this Treaty, and to avoid hampering the economic or technological development of the Parties or international cooperation in the field of peaceful nuclear activities, including the international exchange of nuclear material and equipment for the processing, use or production of nuclear material for peaceful purposes in accordance with the provisions of this article and the principle of safeguarding set forth in the Preamble of the Treaty.

> 4. Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this article either individually or together with other States in accordance with the Statute of the International Atomic Energy Agency . . .

Treaty for the prohibition of nuclear weapons in Latin America (Treaty of Tlatelolco). — Article XIII of the Treaty of Tlatelolco states:

> Each Contracting Party shall negotiate multilateral or bilateral agreements with the International Atomic Energy Agency for the application of its safeguards to its nuclear activities . . .

How Are IAEA Inspections Made?

On the basis of inventory data submitted by the safeguarded state, inspectors look for changes in the inventory since the last inspection, based on receipt and transfer notices. This book inventory then becomes the basis for inspection. To verify the inventory, IAEA inspectors may count, weigh, measure the material, take samples for independent analysis, perform nondestructive tests, inspect seals, and make comparisons with the accounting records.

What Can IAEA Inspections Do? Not Do?

IAEA inspections can verify inventories of nuclear material, and in principle detect diversion of safeguarded material or misuse of a safeguarded facility on the basis of these inventories. Inspection cannot prevent diversion of safeguarded material, and can do nothing about unsafeguarded material or facilities.

How Extensive Is Application of IAEA Safeguards?

States. — By February 1981, 113 non-nuclear weapon states were party to NPT. Of these, 78 had negotiated safeguards agreements and 69 of these had entered into force. Of the remaining states, only three had significant nuclear activity, two of which had begun the procedures for bringing their agreements with the Agency into force. Note, however, that, in these three States, all known nuclear activities are under non-NPT safeguards agreements.

In 1980, the Agency was applying safeguards in 11 non-nuclear-weapon states which were not party to NPT -- namely, Argentina, Brazil, Chile, Colombia, Cuba, the Democratic People's Republic of Korea, India, Israel, Pakistan, South Africa, and Spain. In 6 of these 11 countries all substantial nuclear activities of which the Agency was aware were covered by a mosaic of individual safeguards agreements. In 5 of these 11 countries, and a sixth country, which had signed but not yet ratified the NPT, unsafeguarded nuclear facilities were in operation. In only 4 of these 11 countries was the unsafeguarded facility capable of producing weapons-grade material.

During 1980, safeguards were applied in France, the United Kingdom, and the United States of America to nuclear material which was subject to safeguards under agreements with third countries and which had been returned or transferred to those three states.

Facilities. -- The number of plants under safeguards increased during 1980, from 700 to 774; the plants included certain facilities for which very frequent or continuous inspection was needed.

Materials. -- The quantity of separated plutonium under safeguards decreased by 38 percent to 5 metric tons; the quantity of plutonium contained in spent fuel under safeguards rose by 30 percent to 78 tons; the quantity of highly enriched uranium under safeguards remained at 11tons; safeguarded low-enriched uranium and source material rose by 18 percent and 24 percent, respectively, to 13,872 tons and 19,097 tons.

What Is Involved in Application of IAEA Safeguards in the U.S.?

In 1968, President Johnson pledged that the United States would permit the IAEA to apply its safeguards to all nuclear activities in the United States, excluding only those pertaining directly to national security. This pledge was made to neutralize the complaint of some industrial countries party to the NPT who did not have nuclear weapons and who argued that it was unfair for the U.S. nuclear industry not to be under IAEA safeguards. The United States has negotiated a safeguards agreement with the Agency, which President Carter sent to the Senate for approval as a treaty on Feb. 9, 1978. The Senate approved the agreement on July 2, 1980, and it took effect on Dec. 12, 1980. In March 1981, the IAEA selected three commercial nuclear facilities for application of safeguards: Exxon Nuclear Company's fuel fabrication plant at Richland, Washington; Portland General Electric Company's Trojan nuclear power plant near Prescott, Oregon; and Sacramento Municipal Utility District's Rancho Seco nuclear plant station near Sacramento, California. These NRC licenses will have to furnish information about their facilities, submit reports accounting for their nuclear materials, and permit IAEA inspection.

What Is the Staffing for IAEA Safeguards?

In 1980, the safeguards department of the IAEA had a staff of 324.

What Are the Budgets for Safeguards? How Are They Funded?

In 1980, the regular budget for IAEA's safeguards activities was $21,740,000. In addition, estimated contributions for safeguards, excluding contributions in kind, amounted to $1,490.000 from contributions by Australia, Canada, FRG, USSR, and the US. The United States contribution was $800,000. In addition, a number of states offered the Agency contributions in kind consisting of cost-free experts and consultants, requests for fellowships, training courses, and other. U.S. contributions in kind through the Program of Technical Assistance to Safeguards (POTAS) were approximately $5 million in 1980. Oriented toward improving effectiveness of IAEA safeguards, POTAS programs are administered through the Department of Energy by an interagency commission chaired by a Department of State official. They are funded by Department of State appropriations under the Foreign Assistance Act.

Does the IAEA Have Unused Powers?

The IAEA has some powers that it has not used. It has a right to custody over and storage of "excess. . . special fissionable materials recovered or produced as a by-product. . . to prevent stockpiling of these materials. . ." [Statute, Art. XII, 5.]

Recent Problems

Israeli raid. -- On June 7, 1981, Israeli aircraft attacked an Iraqi research reactor located near Baghdad. An unprecedented preemptive strike against an opponent believed to be developing a nuclear weapons capability, the attack shows Israel had little confidence in the international nonproliferation regime. This is likely to increase concern about weaknesses and gaps in that regime, particularly in IAEA safeguards.

Politicization of agency. -- The 25th General Conference (September 1981) showed signs of serious contention and controversy between several groups or blocs of member states. It concluded with a strong drive by Third World States for more key positions in the Secretariat, more membership on the Board of Governors, and for more support for technical assistance. Also, it is informally understood that the present Director-General will be replaced after one 4-year term by someone favored by the Third World. Politicization was also suggested by attempts to remove Israel and South Africa from the Agency. Such politicization itself might erode the perceived effectiveness of the IAEA safeguards system, the credibility of which is a function of political as well as technical factors. Moreover, Third World demands for more money for technical assistance might or might not reduce funds available for safeguards.

INTERNATIONAL TRAINING COURSE ON NUCLEAR MATERIALS ACCOUNTABILITY FOR SAFEGUARDS PURPOSES

SESSION 3: HISTORICAL AND POLITICAL FRAMEWORK OF SAFEGUARDS

Gerald F. Tape
Associated Universities, Inc.

I. INTRODUCTION

Concern for the misuse of atomic energy has been with us since the dawn of the atomic age. In the early 1940s the scientists' self-imposed control on the then sensitive nuclear information was soon followed by the rigorous policy of classification. With the end of World War II and the early recognition of benefits to be obtained from nuclear developments in the civilian sector, new initiatives were needed; extensive security classification was not the long-term answer. Furthermore, the "facts of nature" could not indefinitely remain known only to a few; they were there for all who would devote the effort and investment to seek them out.

Control in the non-peaceful use of atomic energy has a long history. In November 1945, the President of the United States, the Prime Minister of the United Kingdom and the Prime Minister of Canada stated that international control of the whole field of atomic energy was immediately essential. To quote a portion of their statement:

> "We are aware that the only complete protection for the civilized world from the destructive use of scientific knowledge lies in the prevention of war. No system of safeguards that can be devised will of itself provide an effective guarantee against production of atomic weapons by a nation bent on aggression. Nor can we ignore the possibility of the development of other weapons, or of new methods of warfare, which may constitute as great a threat to civilization as the military use of atomic energy."

From these concerns, there followed a series of international activities culminating in the convening of the United Nations Atomic Energy Commission to consider steps that might be taken to assure the control of atomic weapons. It was there in July 1946 that the U.S. Representative, Mr. Bernard M. Baruch, set forth a plan based upon the Acheson-Lilienthal study. A far-reaching scheme for placing all sensitive nuclear activities under international ownership-management was envisioned. The plan was intended to permit and encourage peaceful uses, while banning military applications even by the U.S. itself, the then sole possessor of atomic weapons.

The U.S. proposed the creation of an International Atomic Development Authority, to which would be entrusted all phases of the development and use of atomic energy, starting with raw material and including

- managerial control or ownership of all atomic-energy activities potentially dangerous to world security;
- power to control, inspect and license all other atomic activities;
- the duty of fostering the beneficial uses of atomic energy; and
- research and development responsibilities of an affirmative character intended to put the Authority in the forefront of atomic knowledge and thus enable it to comprehend, and therefore to detect, misuse of atomic energy.

It was recognized that, to be effective, the Authority must itself be the world's leader in the field of atomic knowledge and development and thus supplement its legal authority with the great power inherent in possession of leadership in knowledge.

The Baruch Plan for internationalizing the atom was farsighted. It set forth the need for restraint in nuclear weapons development and for international safeguards and penalties for diversion in civil nuclear programs. Forgoing manufacture and possession of atomic bombs was a key element of the plan. Soviet opposition led to its rejection, and secrecy continued as the fundamental nuclear policy not only of the U.S. but of other nations as well.

By the early 1950s, it was recognized that the national security classification route could not prevent the steady dispersion of nuclear weapons capabilities. The facts of nature were available for discovery by those who sought them, and they were being acquired. Advanced technologies that could support a nuclear weapons program were being developed or acquired by a number of nations. Many nations, recognizing the benefits to be gained from various nuclear applications, initiated their own indigenous programs. Nuclear power was approaching a stage of practical application, a situation which would lead many countries to engage in nuclear activities even though they had no then present interest in developing nuclear weapons. Without constraints and international understandings, both civil and military objectives would have proceeded simultaneously. A new approach was needed.

The U.S. decided on a major change in its policy. In December 1953, President Eisenhower proposed that there be international cooperation in the peaceful use of nuclear energy under controls to assure that this cooperation would not be diverted to military uses. He also proposed the creation of an international atomic energy agency, which would be the focal point of both the cooperative programs and the international control machinery. The Eisenhower plan differed from the earlier Acheson-Lilienthal concept in one very important respect. Unlike the earlier plan, the new proposals did not call for international ownership and management of sensitive activities. Instead, it contemplated national programs under international safeguards, a system of inspection and control designed to sound the alarm in case any diversion to military uses took place. The implicit assumption was that world reaction to such a serious violation of the rules would deter violations in most cases, and deal effectively with any which might occur.

The Eisenhower Atoms for Peace proposals were generally adopted by the Congress through passage of the Atomic Energy Act of 1954, the same legislation which authorized private civil nuclear activities, including nuclear power, in the U.S. Domestic and international programs and policies were of necessity intimately related from the outset, since a program of international nuclear cooperation could not have been undertaken in the absence of a strong domestic base.

Both the domestic and international peaceful nuclear programs developed quickly after 1954. A domestic nuclear power industry was inaugurated; Shippingport was placed in operation in 1957; and the first privately owned plants were started soon after. Internationally, the U.S. concluded its first cooperative agreements in 1955. The first Geneva Conference on the Peaceful Uses of Atomic Energy was held in the same year, and the International Atomic Energy Agency (IAEA) was established in 1957, near-record time for an international undertaking of this type.

The U.S. was not alone in its efforts to create a new regime based on cooperation under effective controls. Other countries with nuclear capabilities adopted similar policies, and in some important respects preceded the U.S. in their practical application.

As time went on, the fabric of international cooperation and control was strengthened. The novel concept of on-site inspections to assure that no diversion was taking place was not only incorporated into international agreements but put into practice, first by the U.S. bilaterally and later by the international staff of the IAEA. Most countries with nuclear capability adopted the policy of furnishing nuclear assistance only on the condition that it be subject to these safeguards. The U.S. and other suppliers went to great lengths to offer reliable long-term nuclear fuel supply assurances so as to discourage the development of independent sources of supply. As a result, the bulk of the nuclear activities in the world came under this regime, even though there was no legal barrier to any nation's pursuing independent nuclear programs and developing nuclear weapons if it chose to do so. During this period, two additional nations--France in 1960, and the Peoples Republic of China in 1964--developed nuclear explosives, through independent programs dedicated to that purpose. Thus the policy of offering peaceful nuclear assistance under safeguards appeared to be accomplishing its objective of restraining proliferation, if not avoiding it completely.

II. THE INTERNATIONAL ATOMIC ENERGY AGENCY

Launched in response to President Eisenhower's 1953 "Atoms for Peace" appeal for the establishment of an international organization to devise methods whereby "fissionable material would be allocated to use in the peaceful pursuits of mankind," the International Atomic Energy Agency came into existence in 1957 with two basic objectives. Their formulation in the Agency's Statute (Article II) reads as follows:

> "The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."

These are still valid and worthy objectives. They reflect the conflict between the military atom and the peaceful atom; they reflect technical and political realities. They set goals for mankind; on the one hand, to exploit for his benefit a resource of nature through the application of technology in the utilization of nuclear energy, yet, on the other hand, to apply constraints to ensure that such benefits are not realized at the expense of a safe and peaceful coexistence among all inhabitants on this planet.

The Statute is the legislative document upon which the IAEA is founded. It provides for holding of an annual General Conference to which all Member States of the Agency can send delegates. The General Conference has power to discuss any matters relating to the Statute or arising from its implementation. A Board of Governors, created with the authority to carry out the functions of the Agency in accordance with the Statute, reports to the General Conference annually on the Agency's conduct of its affairs. The Statute also provides for the appointment of the Director General as the chief administrative officer of the Agency, responsible to the Board for ensuring that its decisions are effectively carried out.

Over the years the work of the Agency has changed, not in scope but in emphasis. The early demands for information, training, equipment and expert assistance have grown. Nuclear power has become of increasing importance to all nations where new energy resources are now so much in demand. The application of safeguards has been found to be more complex, especially for bulk handling facilities, and additional mechanisms for the assurance of non-diversion are being investigated. The designation of the IAEA by the Non-Proliferation Treaty as the agent for international safeguards has increased the Agency's work load.

III. THE NON-PROLIFERATION TREATY

The Non-Proliferation Treaty (NPT) came into force in 1970. Review conferences are held every five years, the next one is scheduled for Geneva this fall. There are now 112 parties to the Treaty; there still remain a number of important nations that have not acceded.

Non-Nuclear Weapons States (NNWS) parties to the Treaty have pledged not to acquire or manufacture nuclear weapons. Further, a NNWS party agrees to place its nuclear activities under safeguards for "the exclusive purpose of verification of the fulfillment of its obligations assumed under the Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other explosive devices." The IAEA was designated as the international instutitional mechanism to carry out the verification function. The Treaty assures NNWS parties that research, development and production directed toward peaceful means would not be constrained by the Treaty and that all parties would strive for the fullest possible exchange of equipment, materials and scientific and technical information consistent with the undertakings.

There are additional features to the Treaty such as undertakings by the Nuclear Weapons States (NWS) to work toward cessation of the nuclear arms race.

IV. THE TREATY FOR THE PROHIBITION OF NUCLEAR WEAPONS IN LATIN AMERICA

This Treaty, also known as the Treaty of Tlatelolco, was concluded in 1967. Although not equivalent in all respects to the NPT, it contains many strong provisions that support non-proliferation. Because it requires IAEA full-scope safeguards, includes a pledge for use of nuclear materials and facilities for peaceful purposes only and prohibits the presence, production, acquisition, or testing of nuclear weapons within a signatory's territory, adherence to the Treaty is accepted by supplier nations in a manner similar to that for an NPT party.

V. THE CONVENTION ON THE PHYSICAL PROTECTION OF NUCLEAR MATERIAL

Negotiation of an international convention on the physical protection of nuclear material was concluded under IAEA auspices in October 1979. Representatives of 58 States participated in the drafting. The U.S. became a signatory on March 5, 1980, when the Convention was opened for signature.

The Convention addresses the need for the physical protection of nuclear material while in international transport and while in domestic use, storage and transport. It specifies levels of protection, procedures for pursuit and recovery of material, and arrangements for apprehension of offenders. These measures, including the exchange of information on materials in transit, will further assist in the implementation of safeguards.

VI. NON-PROLIFERATION, NON-DIVERSION AND SAFEGUARDS TODAY

Exploitation of nuclear energy for peaceful uses, while constraining proliferation and diversion of special nuclear materials, is dependent upon a strongly and universally supported International Atomic Energy Agency, adherence to the Non-Proliferation Treaty and/or the Treaty for the Prohibition of Nuclear Weapons in Latin America, and acceptability of Nuclear Suppliers' Agreements. Additionally, where direct U.S. cooperation with another nation is involved, there is the Atomic Energy Act of 1954, as amended, that requires international agreements for cooperation, and the Nuclear Non-Proliferation Act of 1978.

In the mid-1970s, there began a re-examination of the policies and practices underlying the non-proliferation regime. It was triggered in part by the Indian nuclear explosion of 1974 and in part by the concern that, with the worldwide growth of nuclear power programs and the assumed accompanying reprocessing of spent fuel, large quantities of plutonium would be readily accessible. Many believe that it is only a short step from available plutonium to a nuclear weapon, that is, that the technical work necessary for design and fabrication is easily accomplished. Doubts were raised that the then existing safeguards system could provide the "timely warning" necessary for diplomatic activity to take place.

These beliefs, the technical one that a nuclear explosive can be made quickly, once the separated plutonium is available, and the political one that appropriate counteraction could not be accomplished on a sufficiently short time scale, gave rise to a conclusion that there exists an unacceptable risk of proliferation even with the best safeguards system. This line of reasoning led to a position that the breeder, reprocessing and the so-called plutonium economy should, at a minimum, be deferred while re-examination took place. As you know, there are differing views on this subject and the International Nuclear Fuel Cycle Evaluation (INFCE) was organized in 1977 to study technically the various elements including alternatives.

VII. THE INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION

There is no question but that INFCE was a most valuable forum that brought parties together to study technically the many aspects of nuclear power development and utilization that could have an impact on nuclear weapons proliferation. It was a useful consciousness-raising exercise for governments and for the public. It will provide governments with extensive information that should assist them in their own decision making and in pointing the way to strengthening the non-proliferation regime.

Let me highlight a number of points, taken from the report, that have or will have a bearing on safeguards-related activities.

1. Nuclear power has and will have continuing value for many national economies. At the same time, there are proliferation risks associated with nuclear power as well as measures that can and should be taken to make such risks more tolerable and manageable.

2. Proliferation is basically a political matter; if a nation elects to develop nuclear explosives, it can do so without misusing civilian nuclear power facilities.

3. Since facilities, however, can be misused, it is important to plan future fuel cycles with careful attention to proliferation risks. No technical solution was identified that will eliminate such risks, but several major positive factors that will be useful in future planning were identified.

4. Substantial risks are associated with weapons-usable materials and the technologies that can produce them. New protective measures, including but not limited to improved safeguards, will be required to cope with fuel cycles involving ready access to significant amounts of weapons-usable materials.

5. While reprocessing is preferred by some nations as the way to deal with spent fuel, other choices are feasible, for example, spent fuel storage and terminal disposal without reprocessing.

6. For economic reasons, when reprocessing plants are built they, like enrichment plants, should be large in scale. Scale is also an important consideration for non-proliferation reasons.

7. The economic advantage of plutonium recycle in light water reactors will at best be small.

8. Effective international safeguards are an essential feature of nuclear fuel cycle facilities. The special need to apply effective safeguards, particularly for the sensitive fuel cycle steps involving enrichment, reprocessing, and fabrication of fuel using plutonium or highly enriched uranium, was recognized. Inclusion of safeguards planning at the earliest stages of plant design is called for. The importance of giving high priority to the testing and optimization of new improved safeguards methods for sensitive fuel cycle steps was emphasized.

9. Constraints that now apply to reprocessing and to separated plutonium need to be reinforced by other protective mechanisms, for example, placing excess plutonium under international oversight.

10. A combination of new safeguards, technical and institutional measures constitutes a promising approach to reducing potential proliferation risks. It will take major efforts by many nations to implement such measures, for example, a new multinational venture, by the time they are needed to deal adequately with the proliferation risks which are inherent in such sensitive facilities as reprocessing and enrichment plants.

The above enumeration is not intended to be all inclusive. It does emphasize the need for greater attention to sensitive technologies and processes and the handling of sensitive materials. It emphasizes the importance of nuclear materials accounting, containment and surveillance, and it emphasizes the importance of institutional mechanisms, the IAEA, the various Treaties and the future potential international or multinational arrangements.

VIII. TRENDS

The world of energy has been undergoing some drastic changes in the past five years, even more changes can be anticipated for the decade of the 1980s. Energy is no longer the relatively cheap, easily available commodity that it once was for many nations of the world. A number of "concerns" are now influencing national and international energy planning. For example:

Concern for limiting the use, especially for export, of a nation's in-the-ground resources--prospect of limited national oil resources.

Concern for public health--pollution from burning coal and oil, nuclear radiation from power-related activities.

Concern for the environment--changes because of new hydro locations, acid rain from fossil plants, ocean spills of oil, nuclear waste management.

Concern for national security--availability of primary energy resources, nuclear proliferation.

Concern for political stability--adequacy of energy resources, stability of world commerce.

The effects of OPEC pricing of petroleum are well-known to you. The concerns expressed above have slowed down the rapid introduction of other supply alternatives so that all energy prices have escalated dramatically. The most striking consequence has been the adoption of an energy conservation ethic, in order, first, to realize real savings, and second, for the electric economy, to buy time before new generating capacity must be added.

The U.S. National Academy of Sciences recently completed a study (CONAES) of nuclear and alternative energy options for the future. There were five general observations offered; however, the one most directly of interest to this audience is that which focussed on the desirability of a balanced combination of coal and nuclear fission as the only large-scale intermediate-term option for electricity generation. This study addressed U.S. needs; however, with a priority on oil for transportation and petrochemicals and, for many nations, the lack of indigenous coal, there could well be a shift by such nations to a strong preference for nuclear. One cannot ignore a nation's present status, for example, its per capita energy consumption and opportunities for growth. The problems, though different, exist for both industrialized and developing nations.

The call for nuclear power is clearly there; the problem for us is to make it acceptable. The IAEA is playing a major role through its programs of education and training and its health and safety guidelines. At the same time, its role in safeguards is necessary in assuring a peaceful uses-only utilization, also an element of public acceptance.

Thermal reactor systems are in operation today and will continue to be built for the indefinite future. There are safeguards requirements for elements of the fuel cycle, front-end requirements for enrichment and fuel element fabrication and back-end requirements for spent fuel storage, reprocessing and waste management. The drive for resource conservation will make the breeder a most likely option for the future; the questions are when and where.

But this optimistic picture of a nuclear power future will take place only if nations have the assurance that it can take place without undue risk to health and to national security. We need the combined efforts--technical, institutional and political--to achieve the objective.

IX. EMPHASIS ON SAFEGUARDS

Nuclear materials accountability for safeguards purposes has been required from the very beginning of international nuclear cooperation. Control and surveillance are being used to augment materials accountability. The emphasis on safeguards has increased with time, in part because of the expanding nuclear economy and in part because of the hope and desire that technical safeguards themselves would be sufficient to prevent proliferation. Improvements have been made and are being made. It is obvious, however, that the final decision of whether or not a violation has occurred will be a combination of judgments, the one derived from the application of safeguards being extremely important.

The institutions and instruments that support non-proliferation ar dependent upon the effective application of safeguards.

- The NPT requires applications of safeguards and assigns the international verification role to the IAEA.
- The suppliers' agreements require IAEA safeguards as a condition for export.
- The U.S. Nuclear Non-Proliferation Act of 1978 emphasizes the role of safeguards and requires the U.S. government to assist in improving international safeguards.
- The INFCE report reinforces the requirement for improved safeguards.

In this day and age of looking to science and technology to cure the world's ills, leaders look to the safeguards system to assure a non-diversion, non-proliferation nuclear world. Although the safeguards system goes a long way, it will never be able to do the job alone. At the same time, other mechanisms cannot do the job without safeguards on which they can build. In short, good safeguards are absolutely necessary.

International safeguards as one element in the overall system builds on national (domestic) safeguards. The international system was never intended to do the whole job; it is intended to verify that the domestic system is working and that an internationally verified conclusion of non-diversion can be accepted with a high degree of confidence.

Thus the IAEA's findings can be no better than the facts upon which they are based, namely, those derived from the national system. In my view, there is opportunity for cooperation even when the IAEA must assume an adversary role. It is in the State's best interest to maintain a good safeguards system and to implement it effectively with accuracy and timeliness. It is in the State's interest to cooperate with the IAEA in making the verification process simple and effective. If the State's own system is ineffective and incomplete, the IAEA will have great difficulty in arriving at a conclusion favorable to the State. If the State has a practice of making the verification process difficult, which it can do in any number of ways, the IAEA may not be able to reach a conclusion of "no diversion" because of lack of supporting information.

X. SUMMARY

It is just over a quarter of a century since President Eisenhower proposed that there be international cooperation in the peaceful use of nuclear energy under controls to assure that this cooperation would not be diverted to military uses. We are in the tenth year of the coming into force of the Non-Proliferation Treaty. The utilization of safeguards as a measure to ensure no diversion to a military purpose was originally directed to national diversion. With the advent of terrorism, greater attention is being given to sub-national activities that may have objectives other than a national military use. Containment and surveillance, along with greater physical protection of sensitive materials and plants, have been added to nuclear materials accounting as measures to prevent as well as to detect unauthorized use.

The success of safeguards is a combination of technical capability, political will and international cooperation. The granting of inspection rights to the IAEA for a nation's total civil nuclear program is a strong indication of a country's concern and an indication of its willingness to cooperate with others in limiting further proliferation that might result from peaceful pursuits. The more effective and the less obtrusive we can make the implementation of safeguards, the easier it will be to overcome political difficulties.

One cannot overlook costs. There are many similarities between safeguards, safety and environmental controls. They are all of a regulatory nature, imposed upon the operators to provide a benefit to society. The advocates will argue that one should do everything possible to protect the public or the environment without regard to cost. This is an unrealistic objective; zero risk is impossible, and certainly one can reach the point of diminishing returns, that is, a rapid increase in costs to achieve a further reduction in an already low risk. The decision of how much is enough is a societal one that is made through the political process.

If we ask the question, could the IAEA and the NPT be created today, the answer is probably not. The existing international institutions and instruments were established at a most propitious time. They do exist, they have made possible bringing the benefits of atomic energy to a far larger fraction of the world's population than otherwise would have been possible. We should be thankful to those who had the foresight and perseverance to give them the strength they have today. The experience gained gives us insight as to ways and means for improvements--increased benefits with increased assurance of no diversion. We must build on our present base of technology, of institutions and of political will.

An effective State system of nuclear materials accountability and control for safeguards purposes provides the basis on which the international system of verification can take place. A weak or questionable safeguards system will not provide the public or nations with the confidence necessary to allow nuclear energy to be used for its greatest benefits to society. It is up to us to foster the technical, institutional and political action necessary to provide that confidence.

INTERNATIONAL TRAINING COURSE ON IMPLEMENTATION
OF STATE SYSTEMS OF ACCOUNTING FOR
AND CONTROL OF NUCLEAR MATERIALS

March 15-30, 1982

SESSION 2: HISTORICAL DEVELOPMENT AND CURRENT TRENDS IN NUCLEAR SAFEGUARDS

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I. INTRODUCTION

We have, in the United States, a saying which goes "no news is good news." With regard to public and press attention, this can be turned around to read "good news is no news." This saying is relevant to the political and public context for peaceful nuclear development and safeguards. In fact, the importance and uniqueness of the international framework for cooperation in peaceful nuclear energy is greatly underestimated. Judged relative to other efforts of the international community, this framework for cooperation is remarkably successful. The measure of this importance and success is to a large extent the fact that there has been remarkably little "news," that is, bad news, either in the reactor safety area, or in theft/terrorist action, or diversion. Maintenance of that good record is enormously important for the continued health of international cooperation in nuclear power. In a narrower sense, "no news is good news" is an accurate description of the reporting function of IAEA safeguards. This presentation will briefly review the historical and political context of the IAEA safeguards system, its principal features, and recent developments and trends.

II. EARLY DEVELOPMENT

From the beginning, those involved in developing the use of nuclear power agonized over the apparently enormous threat of military use, and the enormous potential for peaceful benefits. Attempts to deal with this issue involved several elements, and over time the relative emphasis on these elements has undergone several changes.

Immediately following the second World War, the need for international control was stressed by several governments, and the effort at definition of such international control was launched. Already in 1946, the United States proposed an ambitious plan for international ownership or management of nuclear activities--the Baruch Plan. This plan had the advantage of being fundamentally nondiscriminatory; the military use of nuclear energy was to be completely banned. The concept of international inspection was included, as was the promotion of peaceful uses of nuclear energy. This plan was not accepted, and the long laborious international process of defining and implementing some related (but more modest) steps started again.

The world has never returned to the concept of international safeguards involving physical control, ownership, and management by an international agency. "Safeguards" has ever since been a much more limited idea of monitoring and reporting.

For a period of several years, little progress was made, and tight classification was maintained on nuclear science and technology. Then in 1953, President Eisenhower proposed the "Atoms for Peace" program. The basic approach envisaged cooperation and trade in nuclear training, materials, and technology, combined with creation of an international agency that would apply international control to nuclear material and activities.

In the United States, the legal basis for private civil nuclear activities and for cooperation with other countries is the Atomic Energy Act, passed in 1954 as a result of the Atoms for Peace initiative. Civil nuclear facilities moved rapidly. For example, the Shippingport reactor was already in operation in 1957. Hopes and projections for nuclear power, of course, grew even faster. Our first agreements for cooperation were concluded in 1955. An ambitious international training program was launched. I am continually impressed with the large number, among my foreign colleagues, of outstanding scientists, program administrators, and policy makers who worked together in the United States in this program. In fact, my review of early developments will stop here partly because I so often find real authorities on it in international groups such as this.

III. THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

The Statute of the IAEA sets out, in Article II, two basic objectives:

> "The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."

The international community had chosen its basic route: cooperation in civil nuclear activities, avoidance of use of that cooperation for military purpose, and the use of the IAEA to ensure such peaceful uses. The early history is replete with judgments that the military uses of nuclear weapons could not be avoided, and that widespread development of civil nuclear power would inevitably bring with it widespread nuclear weapons. Nevertheless, the international community had chosen to try.

With regard to safeguards the Statute says:

> "With respect to any...arrangement where the Agency is requested by the parties concerned to apply safeguards, the Agency shall have the following rights and responsibilities...to send into the territory of the recipient State or States inspectors, designated by the Agency after consultation with the State or States concerned, who shall have access at all times to all places and data and to any person...as necessary to account for source and special fissionable materials..."

By the way, it also provides considerable food for thought with the following language in Article XII A 5:

> "The Agency shall have the right "to approve the means to be used for the chemical processing of irradiated materials solely to ensure that this chemical processing will not

> lend itself to diversion of materials for military purposes and will comply with applicable health and safety standards;...and to require deposit with the Agency of any excess of any special fissionable materials recovered or produced as a by-product over what is needed for the above-stated uses in order to prevent stock-piling of these materials, provided that thereafter at the request of the member or members concerned special fissionable materials so deposited with the Agency shall be returned promptly to the member or members concerned for use under the same provisions as stated above;"

This language indicates considerable foresight and concern over the presence of plutonium.

The IAEA safeguards system, fortunately, had time to develop gradually. In the early years of its existence, the job of safeguarding was mainly confined to research reactors and, to an increasing extent, power reactors. The applicable guidance laid out in document INFCIRC/66/Rev. 2 was very general with regard to specific inspection goals and methods. It did, however, provide for IAEA inspection access at all time for large facilities.

IV. THE TREATY FOR THE PROHIBITION OF NUCLEAR WEAPONS IN LATIN AMERICA AND THE NON-PROLIFERATION TREATY

Interest continued in establishment of a treaty basis for nuclear cooperation and peaceful use guarantees. One approach, of a nuclear-free zone, was used in Latin America, where the Treaty of Tlatelolco was concluded in 1967. Consideration of nuclear-free zones in other areas has continued. The concept of the nuclear-free zone is based on the increase of security of States in the area by exclusion of nuclear weapons, and increase of confidence by application of IAEA safeguards to all nuclear activities in States party.

The Non-Proliferation Treaty, which came into force in 1970, is an attempt at a world-wide commitment to nonproliferation of nuclear weapons. Non-Nuclear Weapons States (NNWS) parties to the Treaty have pledged not to acquire or manufacture nuclear weapons. A NNWS party agrees to place all its nuclear activities under safeguards for

> "the exclusive purpose of verification of the fulfillment of its obligations assumed under the Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other explosive devices."

During the period just prior to entry into force of the NPT, a committee of the whole membership of the IAEA drafted a model safeguards agreement for fulfilling NPT obligations - INFCIRC/153. This model added considerable precision and specificity to concepts and approaches of IAEA safeguards, including a set of guidelines for amount of inspection and a set of protections for the inspected nuclear programs.

The NPT contains other obligations, in particular, relating to promoting the fullest possible exchange of equipment, material and technology, and measures to halt and reverse the nuclear arms race between the nuclear weapon states.

Two Review Conferences of the NPT have been held, in 1975 and 1980. These reviews have underscored the feeling of many parties that more progress must be made in nuclear arms control. The reviews have also strongly supported the importance of IAEA safeguards and stressed the need for continued development and improvement of safeguards.

V. DEVELOPMENTS IN THE MID-1970s

There were a set of interrelated developments in the mid-1970s, which influenced attitudes and perceptions of the proliferation problem and of the role of safeguards. One, of course, was the nuclear explosion by India in 1974, and the resulting agonizing review of those whose cooperation or supply somehow contributed to that explosion. I believe, however, that other developments were also important. For example, oversimplified reports of potential United States reactor supply to Israel and Egypt triggered considerable rethinking in the US Congress. The increase in terrorism led naturally to concern over the presence of material that could be used for nuclear weapons. Also, the logic and rhetoric and planning of nuclear programs envisaged early and widespread reprocessing for plutonium use, primarily in breeder reactors. On the other hand, breeder programs themselves move more slowly than predicted, and resulting projections of excess plutonium appeared very ominous. At the same time, nuclear power programs lagged much behind projections, and large uranium deposits were found, also adding to questioning of the immediate need for reprocessing. Finally, increased competition for international sales of reactors and fuel led to an appreciation of the potentially very unfortunate effects of differing safeguards policies.

With regard to safeguards, these developments seemed suddenly to make the need for effectiveness much more immediate. And they led to focus on the question of what constitutes "timely" detection of diversion.

One resulting development was discussions among nuclear suppliers and the announcement by several suppliers of identical export principles. The reason for these discussions was primarily that one major supplier did not have an obligation to require safeguards on its exports. The focus was, therefore, a restatement of that export policy, and an updating of the detailed list of items which, if exported, would require safeguards.

A second development was the passage in the United States of the Nuclear Non-Proliferation Act of 1978. That Act amended our basic Atomic Energy Act, making the export process and requirements more specific. It also set out general goals and strongly supported the IAEA safeguards system.

As is quite predictable, the questioning of long-held assumptions about nuclear developments was very unsettling to people in many countries trying to move forward with nuclear power programs. This was particularly so in cases when the questioning seemed to have a weak technical basis, when cooperative arrangements seemed to be put in doubt, or when it seemed that guidelines were being set in small groups without input from the broad membership of the IAEA.

It became quite clear that we needed an open international examination of the relationship of the nuclear fuel cycle, nuclear supply, proliferation risks, and nonproliferation measures.

VI. THE INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION

The INFCE was launched in October 1977. The participating governments

> "were conscious of the urgent need to meet the world's energy requirements and that nuclear energy for peaceful purposes should be made widely available to that end;
>
> were convinced that effective measures can and should be taken at the national level and through international agreements to minimize the danger of proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes;
>
> recognized that special consideration should be given to the specific needs of and conditions in developing countries."

The magnitude of the study effort was unprecedented. The results were contained in nine volumes of the final report. Obviously, all aspects of the questions were addressed in these reports, and by careful selection it can appear that INFCE endorsed just about any view. I believe, however, that an overall reading of the reports would indicate that the following points are a reasonable reflection of the analysis done:

- Nuclear power will be of increasing importance in meeting electrical energy needs.
- The role of nuclear power and the fuel cycle choices in individual countries are highly dependent on specific needs, resource availability, and technical infrastructure.
- No fuel cycle is without some proliferation risk, and there is no single technical approach that fits all needs and minimizes those risks.
- However, special approaches are necessary to minimize or deal with the more sensitive fuel cycle aspects, such as enrichment and reprocessing.
- The IAEA should play a central role in such approaches; in particular, the safeguards system must be supported and improved to deal with large future bulk-handling facilities.

Beyond its specific results, the INFCE study was very useful in establishing detailed international dialogue, in removing some misunderstanding, and in pointing towards certain follow-on work.

VII. CONCLUSION

This very brief review has only mentioned certain specific developments as they relate to IAEA safeguards. In conclusion, I would like to mention certain current efforts and possible future directions.

At the IAEA, a study of an international plutonium storage system, and of its relationship to the IAEA safeguards system, is going forward. This system could add modest but useful aspects to the application of safeguards: the declaration and verification of end use, and the avoidance of national stockpiles of separated excess plutonium.

Also at the IAEA, a Committee on Assurances of Supply is organizing its work, which will relate to safeguards aspects of supply.

The United Kingdom, France, and the United States are all bringing into effect agreements with the IAEA permitting the application of IAEA safeguards in those countries. These are of considerable importance in achieving near-universal acceptance of IAEA safeguards on civil nuclear facilities.

Finally, in the United States, a new administration has indicated its strong interest in nuclear power and in stable supply relationships. We intend to work actively with the IAEA and other interested states to support its safeguards system and its technical programs of interest to members, particularly in such key areas as manpower training and reactor safety.

In fact, it is clear that a recurrent theme of the developments I have listed is the repeated reiteration of the importance of the IAEA and its safeguards system, and the necessity of support for improvements in the system. That emphasis will almost certainly continue as suppliers and consumers become increasingly dependent on nuclear supply relationships.

The one uncertainty with regard to this continued support relates to the possibility of such events as diversion, abrogation, or a serious interference with IAEA safeguards by an inspected state. Such an event would be a major setback. But if the IAEA performs its functions of detection and reporting to its Board of Governors, it is likely to be able to survive such an event.

With regard to the substance of IAEA safeguards implementation, there is the question of the technical standards of IAEA safeguards. Specific requirements, in terms of quantities to be detected, detection times, or confidence in detection, have not been formally set by the Board of Governors. The IAEA has, following discussion in the Standing Advisory Group on Safeguards Implementation, adopted certain goals based on quantities and times of significance for nuclear explosives. It has been emphasized, however, that these are goals are not requirements. In fact, implementation in practice probably often does not achieve these goals. Also, the confidence in detection may not often reach the high levels that are desirable. It seems likely that the goals will be maintained, but will be approached as technical capabilities improve over time.

The application of safeguards is now encountering in practice difficult technical challenges at specific facility types, such as large enrichment, reprocessing, and fuel fabrication plants. Much of the technical development work done on safeguards is now devoted to these facility types. Success will not be easy and will require considerable resources and dedication. As a related point, the logistics of world-wide application of IAEA safeguards will be an increasing challenge. It seems likely that new approaches to recruiting, training, and field offices may be necessary.

I would like to close with a comment related to the question of recruiting. One political point often made in the IAEA Board of Governors is the desire for some geographical balance in the recruiting of inspectors. I would like to strongly endorse that desire, and to recommend to all of you in an international group such as this that you actively seek out promising people from your own technical organizations who might serve with the IAEA. They will benefit from experience with the IAEA, as will your own organizations. The IAEA will also benefit, most importantly because the application of safeguards worldwide is greatly facilitated by the understanding and experience, which its former staff bring to national systems.

PART II

SOME BASIC DOCUMENTS

EXCERPT

A REPORT ON THE INTERNATIONAL CONTROL OF ATOMIC ENERGY

Prepared for

THE SECRETARY OF STATE'S COMMITTEE ON
ATOMIC ENERGY

by a Board of Consultants:

Chester I. Barnard
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David E. Lilienthal, Chairman

Washington, D. C. March 16, 1946

SECTION I

Background of the Problem

This report is a preliminary study of the international control of atomic energy. It has been prepared to contribute to the clarification of the position of the U. S. Representative on the United Nations Commission on atomic energy set up by resolution of the United Nations General Assembly to inquire into all phases of this question.

The Commitment for International Control.

We were given as our starting point a political commitment already made by the United States to seek by all reasonable means to bring about international arrangements to prevent the use of atomic energy for destructive purposes and to promote the use of it for the benefit of society. It has not been part of our assignment to make a detailed analysis of the arguments which have led the Government of the United States in concert with other nations to initiate these steps for international action. By way of background, however, it is useful to review some of the main reasons which have influenced the people of the United States and its Government in this course. These reasons were first definitely formulated in the Agreed Declaration of November 15, 1945, issued by the President of the United States and the Prime Ministers of the United Kingdom and Canada. An understanding of the declarations in that document will itself throw considerable light on the criteria by which any specific proposals for international control may be judged.

The Agreed Declaration cites three reasons for seeking international control. This Declaration recognizes that the development of atomic energy, and the application of it in weapons of war, have placed at the disposal of mankind "means of destruction hitherto unknown." The American people have been quick to recognize the really revolutionary character of these weapons, particularly as weapons of strategic bombardment aimed at the destruction of enemy cities and the eradication of their populations. Enough has been said to make unnecessary a repetition of the probable horrors of a war in which atomic weapons were used by both combatants against the cities of their enemy. But it is hardly possible to overestimate the deep impression of horror and concern which insight into these future possibilities has made so widespread.

The second point recognized in the Agreed Declaration is that there can be no adequate military defense against atomic weapons. A great mass of expert testimony is involved in an appreciation of the firmness of this point, but it appears to be accepted without essential reservation, and subject only to an appropriate openmindedness, about what the remote future of technical developments in the arts of war may bring.

The third point, and again we quote from the Agreed Declaration, is that these are weapons "in the employment of which no single nation can in fact have a monopoly." Of the three, this is perhaps the most controversial. Strong arguments have been brought forward that the mass of technical and scientific knowledge and experience needed for the successful development of atomic weapons is so great that the results attained in the United States cannot be paralleled by independent work in other nations. Strong arguments have also been put forward that the degree of technical and industrial advancement required for the actual realization of atomic weapons could hardly be found in other parts of the world. These arguments have been met with great and widespread skepticism. It is recognized that the basic science on which the release of atomic energy rests is essentially a world-wide science, and that in fact the principal findings required for the success of this project are well known to competent scientists throughout the world. It is recognized that the industry required and the technology developed for the realization of atomic weapons are the same industry and the same technology which play so essential a part in man's almost universal striving to improve his standard of living and his control of nature. It is further recognized that atomic energy plays so vital a part in contributing to the military power, to the possible economic welfare, and no doubt to the security of a nation, that the incentive to other nations to press their own developments is overwhelming.

Thus the Agreed Declaration bases its policy on the revolutionary increase in the powers of destruction which atomic weapons have injected into warfare, and on the fact that neither countermeasures nor the maintenance of secrecy about our own developments offers any adequate prospect of defense.

There are perhaps other considerations which have contributed to the popular understanding of the necessity for international control, although they do not appear explicitly in the Agreed Declaration. The United States is in a rather special position in any future atomic warfare. Our political institutions, and the historically established reluctance of the United States to take the initiative in aggressive warfare, both would seem to put us at a disadvantage with regard to surprise use of atomic weapons. This suggests that although our present position, in which we have a monopoly of these weapons, may appear strong, this advantage will disappear and the situation may be reversed in a world in which atomic armament is general.

The atomic bomb appeared at the very end of hostilities at a time when men's thoughts were naturally turning to devising methods for the prevention of war. The atomic bomb made it clear that the plans which had been laid at San Francisco for the United Nations Organization would have to be supplemented by a specific control of an instrument of war so terrible that its uncontrolled development would not only intensify the ferocity of warfare, but might directly contribute to the outbreak of war. It is clear, too, that in the solution of this relatively concrete and most urgent problem of protecting mankind from the evils of atomic warfare, there has been created an opportunity for a collaborative approach to a problem which could not otherwise be solved, and the successful international solution of which would contribute immeasurably to the prevention of war and to the strengthening of the United Nations Organization. On the one hand, it seemed unlikely that the United Nations Organization could fulfill its functions without attempting to solve this problem. On the other hand, there was hope and some reason to believe that in attempting to solve it, new patterns of cooperative effort could be established which would be capable of extension to other fields, and which might make a contribution toward the gradual achievement of a greater degree of community among the peoples of the world. Although these more general considerations may appear secondary to the main purposes of this report, they are not irrelevant to it. There is another phrase of the Agreed Declaration which rightly asserts "that the only complete protection for the civilized world from the destructive use of scientific knowledge lies in the prevention of war."

The proposals which we shall make in this report with regard to the international control of atomic energy must of course be evaluated against the background of these considerations which have led to the universal recognition of the need for international control. We must ask ourselves to what extent they would afford security against atomic warfare; to what extent they tend to remove the possibility of atomic weapons as a cause of war; to what extent they establish patterns of cooperation which may form a useful precedent for wider application. We ourselves are satisfied that the proposals in this report provide the basis of a satisfactory answer to these questions.

Early Ideas on Safeguards.

So much for the main outline of the political action that led to the setting up of the United Nations Commission on atomic energy. There is a further aspect of the general background that also requires discussion at the outset. When the news of the atomic bomb first came to the world there was an immediate reaction that a weapon of such devastating force must somehow be eliminated from warfare; or to use the common expression, that it must be "outlawed". That efforts to give specific content to a system of security have generally proceeded from this initial assumption is natural enough. But the reasoning runs immediately into this fact: The development of atomic energy for peaceful purposes and the development of atomic energy for bombs are in much of their course interchangeable and interdependent. From this it follows that although nations may agree not to use in bombs the atomic energy developed within their borders, the only assurance that a conversion to destructive purposes would not be made would be the pledged word and the good faith of the nation itself. This fact puts an enormous pressure upon national good faith. Indeed it creates suspicion on the part of other nations that their neighbors' pledged word will not be kept. This danger is accentuated by the unusual characteristics of atomic bombs, namely their devastating effect as a surprise weapon, that is, a weapon secretly developed and used without warning. Fear of such surprise violation of pledged word will surely break down any confidence in the pledged word of rival countries developing atomic energy if the treaty obligations and good faith of the nations are the only assurances upon which to rely.

Such considerations have led to a preoccupation with systems of inspection by an international agency to forestall and detect violations and evasions of international agreements not to use atomic weapons. For it was apparent that without international enforcement no system of security holds any real hope at all.

In our own inquiry into possibilities of a plan for security we began at this point, and studied in some detail the factors which would be involved in an international inspection system supposed to determine whether the activities of individual nations constituted evasions or violations of international outlawry of atomic weapons.

We have concluded unanimously that there is no prospect of security against atomic warfare in a system of international agreements to outlaw such weapons controlled *only* by a system which relies on inspection and similar police-like methods. The reasons supporting this conclusion are *not merely technical,* but primarily the inseparable political, social, and organizational problems involved in enforcing agreements between nations each free to develop atomic energy but only pledged not to use it for bombs. National rivalries in the development of atomic energy readily convertible to destructive purposes are the heart of the difficulty. So long as intrinsically dangerous activities may be carried on by nations, rivalries are inevitable and fears are engendered that place so great a pressure upon a system of international enforcement by police methods that no degree of ingenuity or technical competence could possibly hope to cope with them. We emphasize this fact of national rivalry in respect to intrinsically dangerous aspects of atomic energy because it was this fatal defect in the commonly advanced proposals for outlawry of atomic weapons coupled with a system of inspection that furnished an important clue to us in the development of the plan that we recommend later in this report.

We are convinced that if the production of fissionable materials by national governments (or by private organizations under their control) is permitted, systems of inspection cannot by themselves be made "effective safeguards . . . . to protect complying states against the hazards of violations and evasions."

It should be emphasized at this point that we do not underestimate the need for inspection as a component, and a vital one, in any system of safeguards—in any system of effective international controls. In reading the remainder of this section it is essential to bear in mind that throughout the succeeding sections of this report we have been concerned with discovering what other measures are required in order that inspection might be so limited and so simplified that it would be practical and could aid in accomplishing the purposes of security.

The remainder of this section, however, is concerned with outlining the reasons for our conclusion that a system of inspection superimposed on *an otherwise uncontrolled exploitation of atomic energy by national governments* will not be an adequate safeguard.

The Technical Problem of Inspection.

Although, as we have said, a system of inspection cannot be judged on technical grounds alone, an understanding of the technical problem is necessary in order to see what an inspection system would involve. The general purpose of such inspection (that is, inspection as the sole safeguard) would be to assure observance of international agreements according to which certain national activities leading more or less definitely to atomic armament would be renounced, and others which have as their purpose peaceful applications of atomic energy would be permitted. The fact that in much of their course these two types of activity are identical, or nearly identical, makes the problem one of peculiar difficulty.

In our study of the technical factors involved in appraising systems of inspection, we were greatly aided by consultations with the Technical Committee reporting to the War Department on the technical aspects of this problem.* We are indebted to this uniquely qualified group of experts for helpful discussions and for making available to us many of their reports, without which we should doubtless have been very much slower to understand the situation.

As a result of our work with this Committee, we are clear: That every stage in the activity, leading from raw materials to weapon, needs some sort of control, and that this must be exercised on all of the various paths that may lead from one to the other; that at no single point can *external* control of an operation be sufficiently reliable to be an adequate sole safeguard; that there is need for a very extensive and technically highly qualified and varied staff if the job is to be done at all; that the controlling agency must itself be active in research and development, and well informed on what is an essentially living art; and that, for effective control, the controlling organization must be as well and as thoroughly informed about the operations as are the operators themselves. Finally—and this we regard as the decisive consideration—we believe that an examination of these and other necessary preconditions for a successful scheme of inspection will reveal that *they cannot be fulfilled in any organizational arrangements in which the only instrument of control is inspection.*

A fundamental objection to an agency charged solely with inspection is that it will inevitably be slow to take into account changes in the science and technology of the field. One cannot look intelligently for a factory of whose principle of design and operation one has never heard. One cannot effectively inspect if the purpose of the operator is to conceal the discoveries by which he hopes to evade inspection. In a field as new and as subject to technical variation and change as this, the controlling agency must be at least as inventive and at least as well informed as any agency which may attempt to evade control.

Human Factors in Inspection.

Even more important than the technical difficulties of realizing an adequate system of inspection, against a background of national rivalry in the field of atomic energy, or through an organization whose major or whose sole directive is suppressive, are the many human factors which in such an arrangement would tend to destroy the confidence and the cooperation essential to its success. The first of these appears when we ask whether it would in fact be possible to recruit the very large and very highly qualified organization of experts and administrators needed for the work. The work itself, which would be largely policing and auditing and attempting to discover evidences of bad faith, would not be attractive to the type of personnel essential for the job. The activity would offer the inspectors a motive pathetically inadequate to their immense and dreary task.

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*Membership of this Technical Committee on Inspection and Control established by the Manhattan District included L. W. Alvarez, R. F. Bacher, L. A. Bliss, S. G. English, A. B. Kinzel, P. Morrison, F. G. Spedding, C. Starr, Col. W. J. Williams, and Manson Benedict, Chairman.

The presence of a large number of "foreigners" necessarily having special privileges and immunities inquiring intimately and generally into industrial and mining operations would be attended by serious social frictions. For adequate inspection the numbers are large. As an example, it has been estimated that for a diffusion plant operated under national auspices, to offer any real hope of guarding against diversion, 300 inspectors would be required. They would have to check not merely accounts and measuring instruments but also individuals personally. Inquiries would need to be made of individuals without regard to rank or general status. Moreover, it would be especially important to check the location and employment of scientists and many technologists, probably including students. Industrial secrets would be at least to some extent open to "prying". The effect of this would vary with countries. It would probably be as obnoxious to Americans as to any others. Its corrosive effect upon the morale and loyalty of the inspecting organization would be serious.

Some of the organizational difficulties involved in intimate inspection "down the line" of one organization by another are known from experiences that are undoubtedly mild compared with what we should anticipate here. The following are illustrative of the political difficulties of practical operation (quite apart from those to be expected in adopting the international system to begin with). Adequate surveillance by inspection as the sole or primary means of control involves a persistent challenge of the good faith of the nations inspected. If this were confined to relations between the chancellories and general military staffs the difficulty while serious might not be insuperable. But official questioning of the good faith of a nation by concrete action of inspectors among its citizens is another matter and would tend to produce internal as well as external political problems. A somewhat similar problem is involved when a government (or its officials or employees) interferes with the functions of inspectors or molests or threatens them personally, or bribes or coerces them, or *is accused of doing any of these things.* Such incidents could not be avoided.

Some may question whether nations would possess strong incentives to illicit operations, if they actually agreed to forego the production and use of fissionable materials for purposes of war. It is obvious, however, that suspicion by one nation of the good faith of another and the fear engendered thereby are themselves strong incentives for the first to embark on secret illicit operations. The raw materials of atomic energy, potentially valuable for new peacetime purposes and of critical importance for war, are already a matter of extreme competition between nations. The forces growing out of this situation and making for acute rivalry between nations seem to us far more powerful than those which cause the present rivalries with respect to such resources as oil. The efforts that individual states are bound to make to increase their industrial capacity and build a reserve for military potentialities will inevitably undermine any system of safeguards which permits these fundamental causes of rivalry to exist. In short, any system based on outlawing the purely military development of atomic energy and relying solely on inspection for enforcement would at the outset be surrounded by conditions which would destroy the system.

There is much technical information which underlies our belief that inspection can be effective only if it is supplemented by other steps to reduce its scope to manageable proportions, to limit the things that need to be inspected, to simplify their inspection, and to provide a pattern of organization which on the one hand will be of assistance to the controlling agency, and on the other will minimize organizational sources of conflict and the inducements to evasion. Much of this technical information is interwoven with later sections of this report. As the facts on which we base our recommendations for a workable plan of control are discussed, the detailed considerations which led to the conclusion stated in this section will appear more concretely than in the foregoing summary.

SECTION II

Principal Considerations in Developing a System of Safeguards

At the outset of our inquiry we were preoccupied with some way of making an inspection system provide security. This is a preoccupation that is apparently common to most people who have seriously tried to find some answer to the extraordinarily difficult problem presented by the atomic bomb. But as day after day we proceeded with our study of the facts concerning atomic energy, and reflected upon their significance, we were inescapably driven to two conclusions: (a) the facts preclude any reasonable reliance upon inspection as the primary safeguard against violations of conventions prohibiting atomic weapons, yet leaving the exploitation of atomic energy in national hands; (b) the facts suggest quite clearly a reasonable and workable system that may provide security, and even beyond security, foster beneficial and humanitarian uses of atomic energy.

What Should be the Characteristics of an Effective System of Safeguards:

It may be helpful to summarize the characteristics that are desirable and indeed essential to an effective system of safeguards; in other words, the criteria for any adequate plan for security.

a. Such a plan must reduce to manageable proportions the problem of enforcement of an international policy against atomic warfare.

b. It must be a plan that provides unambiguous and reliable danger signals if a nation takes steps that do or may indicate the beginning of atomic warfare. Those danger signals must flash early enough to leave time adequate to permit other nations—alone or in concert—to take appropriate action.

c. The plan must be one that if carried out will provide security; but such that if it fails or the whole international situation collapses, any nation such as the United States will still be in a relatively secure position, compared to any other nation.

d. To be genuinely effective for security, the plan must be one that is not wholly negative, suppressive, and police-like. We are not dealing simply with a military or scientific problem but with a problem in statecraft and the ways of the human spirit. Therefore the plan must be one that will tend to develop the beneficial possibilities of atomic energy and encourage the growth of fundamental knowledge, stirring the constructive and imaginative impulses of men rather than merely concentrating on the defensive and negative. It should, in short, be a plan that looks to the promise of man's future well-being as well as to his security.

e. The plan must be able to cope with new dangers that may appear in the further development of this relatively new field. In an organizational sense therefore the plan must have flexibility and be readily capable of extension or contraction.

f. The plan must involve international action and minimize rivalry between nations in the dangerous aspects of atomic development.

The facts we have come to think essential, and the elements of our thinking as we moved toward the plan we herein recommend, are set out in this section, in the form of the considerations that are relevant to an effective program for security, and that have led us to devise what we believe is an adequate plan.

United States Atomic Energy Proposals

Presented to the United Nations Atomic Energy Commission by Bernard M. Baruch, the United States Representative, June 14, 1946

MY FELLOW MEMBERS OF THE UNITED NATIONS ATOMIC ENERGY COMMISSION, and MY FELLOW CITIZENS OF THE WORLD:

We are here to make a choice between the quick and the dead. That is our business.

Behind the black portent of the new atomic age lies a hope which, seized upon with faith, can work our salvation. If we fail, then we have damned every man to be the slave of Fear. Let us not deceive ourselves: We must elect World Peace or World Destruction.

Science has torn from nature a secret so vast in its potentialities that our minds cower from the terror it creates. Yet terror is not enough to inhibit the use of the atomic bomb. The terror created by weapons has never stopped man from employing them. For each new weapon a defense has been produced, in time. But now we face a condition in which adequate defense does not exist.

Science, which gave us this dread power, shows that it *can* be made a giant help to humanity, but science does *not* show us how to prevent its baleful use. So we have been appointed to obviate that peril by finding a meeting of the minds and the hearts of our peoples. Only in the will of mankind lies the answer.

It is to express this will and make it effective that we have been assembled. We must provide the mechanism to assure that atomic energy is used for peaceful purposes and preclude its use in war. To that end, we must provide immediate, swift, and sure punishment of those who violate the agreements that are reached by the nations. Penalization is essential if peace is to be more than a feverish interlude between wars. And, too, the United Nations can prescribe individual responsibility and punishment on the principles applied at Nürnberg by the Union of Soviet Socialist Republics, the United Kingdom, France, and the United States—a formula certain to benefit the world's future.

In this crisis, we represent not only our governments but, in a larger way, we represent the peoples of the world. We must remember that the peoples do not belong to the governments but that the governments belong to the peoples. We must answer their demands; we must answer the world's longing for peace and security.

* * * *

The United States proposes the creation of an International Atomic Development Authority, to which should be entrusted all phases of the development and use of atomic energy, starting with the raw material and including—

1. Managerial control or ownership of all atomic-energy activities potentially dangerous to world security.
2. Power to control, inspect, and license all other atomic activities.
3. The duty of fostering the beneficial uses of atomic energy.
4. Research and development responsibilities of an affirmative character intended to put the Authority in the forefront of atomic knowledge and thus to enable it to comprehend, and therefore to detect, misuse of atomic energy. To be effective, the Authority must itself be the world's leader in the field of atomic knowledge and development and thus supplement its legal authority with the great power inherent in possession of leadership in knowledge.

I offer this as a basis for beginning our discussion.

But I think the peoples we serve would not believe—and without faith nothing counts—that a treaty, merely outlawing possession or use of the atomic bomb, constitutes effective fulfilment of the instructions to this Commission. Previous failures have been recorded in trying the method of simple renunciation, unsupported by effective guaranties of security and armament limitation. No one would have faith in that approach alone.

* * * *

When an adequate system for control of atomic energy, including the renunciation of the bomb as a weapon, has been agreed upon and put into effective operation and condign punishments set up for violations of the rules of control which are to be stigmatized as international crimes, we propose that—

1. Manufacture of atomic bombs shall stop;
2. Existing bombs shall be disposed of pursuant to the terms of the treaty; and
3. The Authority shall be in possession of full information as to the know-how for the production of atomic energy.

Let me repeat, so as to avoid misunderstanding: My country is ready to make its full contribution toward the end we seek, subject of course to our constitutional processes and to an adequate system of control becoming fully effective, as we finally work it out.

Now as to violations: In the agreement, penalties of as serious a nature as the nations may wish and as immediate and certain in their execution as possible should be fixed for—

1. Illegal possession or use of an atomic bomb;
2. Illegal possession, or separation, of atomic material suitable for use in an atomic bomb;
3. Seizure of any plant or other property belonging to or licensed by the Authority;
4. Wilful interference with the activities of the Authority;
5. Creation or operation of dangerous projects in a manner contrary to, or in the absence of, a license granted by the international control body.

It would be a deception, to which I am unwilling to lend myself, were I not to say to you and to our peoples that the matter of punishment lies at the very heart of our present security system.

* * * *

As matters now stand several years may be necessary for another country to produce a bomb, *de novo.* However, once the basic information is generally known, and the Authority has established producing plants for peaceful purposes in the several countries, an illegal seizure of such a plant might permit a malevolent nation to produce a bomb in 12 months, and if preceded by secret preparation and necessary facilities perhaps even in a much shorter time. The time required—the advance warning given of the possible use of a bomb—can only be generally estimated but obviously will depend upon many factors, including the success with which the Authority has been able to introduce elements of safety in the design of its plants and the degree to which illegal and secret preparation for the military use of atomic energy will have been eliminated. Presumably no nation would think of starting a war with only one bomb.

This shows how imperative speed is in detecting and penalizing violations.

* * * *

I now submit the following measures as representing the fundamental features of a plan which would give effect to certain of the conclusions which I have epitomized.

1. General. The Authority should set up a thorough plan for control of the field of atomic energy, through various forms of ownership, dominion, licenses, operation, inspection, research, and management by competent personnel. After this is provided for, there should be as little interference as may be with the economic plans and the present private, corporate, and state relationships in the several countries involved.

2. Raw Materials. The Authority should have as one of its earliest purposes to obtain and maintain complete and accurate information on world supplies of uranium and thorium and to bring them under its dominion. The precise pattern of control for various types of deposits of such materials will have to depend upon the geological, mining, refining, and economic facts involved in different situations.

The Authority should conduct continuous surveys so that it will have the most complete knowledge of the world geology of uranium and thorium. Only after all current information on world sources of uranium and thorium is known to us all can equitable plans be made for their production, refining, and distribution.

3. Primary Production Plants. The Authority should exercise complete managerial control of the production of fissionable materials. This means that it should control and operate all plants producing fissionable materials in dangerous quantities and must own and control the product of these plants.

4. Atomic Explosives. The Authority should be given sole and exclusive right to conduct research in the field of atomic explosives. Research activities in the field of atomic explosives are essential in order that the Authority may keep in the forefront of knowledge in the field of atomic energy and fulfil the objective of preventing illicit manufacture of bombs. Only by maintaining its position as the best-informed agency will the Authority be able to determine the line between intrinsically dangerous and non-dangerous activities.

5. Strategic Distribution of Activities and Materials. The activities entrusted exclusively to the Authority because they are intrinsically dangerous to security should be distributed throughout the world. Similarly, stockpiles of raw materials and fissionable materials should not be centralized.

6. Non-Dangerous Activities. A function of the Authority should be promotion of the peacetime benefits of atomic energy.

Atomic research (except in explosives), the use of research reactors, the production of radioactive tracers by means of non-dangerous reactors, the use of such tracers, and to some extent the production of power should be open to nations and their citizens under reasonable licensing arrangements from the Authority. Denatured materials, whose use we know also requires suitable safeguards, should be furnished for such purposes by the Authority under lease or other arrangement. Denaturing seems to have been overestimated by the public as a safety measure.

7. Definition of Dangerous and Non-Dangerous Activities. Although a reasonable dividing line can be drawn between dangerous and non-dangerous activities, it is not hard and fast. Provision should, therefore, be made to assure constant re-examination of the questions and to permit revision of the dividing line as changing conditions and new discoveries may require.

8. Operations of Dangerous Activities. Any plant dealing with uranium or thorium after it once reaches the potential of dangerous use must be not only subject to the most rigorous and competent inspection by the Authority, but its actual operation shall be under the management, supervision, and control of the Authority.

9. Inspection. By assigning intrinsically dangerous activities exclusively to the Authority, the difficulties of inspection are reduced. If the Authority is the only agency which may lawfully conduct dangerous activities, then visible operation by others than the Authority will constitute an unambiguous danger signal. Inspection will also occur in connection with the licensing functions of the Authority.

10. Freedom of Access. Adequate ingress and egress for all qualified representatives of the Authority must be assured. Many of the inspection activities of the Authority should grow out of, and be incidental to, its other functions. Important measures of inspection will be associated with the tight control of raw materials, for this is a keystone of the plan. The continuing activities of prospecting, survey, and research in relation to raw materials will be designed not only to serve the affirmative development functions of the Authority but also to assure that no surreptitious operations are conducted in the raw-materials field by nations or their citizens.

11. Personnel. The personnel of the Authority should be recruited on a basis of proven competence but also so far as possible on an international basis.

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THE UNITED STATES AND THE UNITED NATIONS REPORT SERIES 8

The International Control of Atomic Energy

THE FIRST REPORT OF THE
United Nations Atomic Energy Commission
TO THE
Security Council

December 31, 1946

DEPARTMENT OF STATE
UNITED STATES OF AMERICA

Part V: *First Report on Safeguards Required To Ensure the Use of Atomic Energy Only for Peaceful Purposes*

Chapter 1: General Introduction

THE MAJOR TASK BEFORE the Atomic Energy Commission is to make specific proposals for the control of atomic energy in order to foster its use only for peaceful purposes and to prevent its use for destructive ends. This task has led us to an analysis of the types of safeguards necessary to afford protection against the hazards of violations and evasions. The report contains the first findings of Committee 2, limited to this aspect of the general problem. These findings have led to the conclusion that a single international control agency must be responsible for the system of safeguards and control. The Committee has not discussed the general characteristics of such an agency or its exact powers in the way, for example, of development, research, or the international planning of atomic energy production. Nor has it considered how the various safeguards would be administered in practice as part of an over-all system.

The report has been prepared in accordance with the following resolution adopted by Committee 2 on October 8, 1946:

> "That Committee 2 proceed to examine and report on the safeguards required at each stage in the production and use of atomic energy for peaceful purposes to prevent the possibilities of misuse indicated in the Report of the Scientific and Technical Committee; that the Committee may hold informal meetings as it may decide, at which scientific Representatives may take part in the discussions."

The program of work adopted by Committee 2, on October 21, 1946, called for the consideration of three distinct kinds of possible misuse: diversion of materials, clandestine operations, and seizures of material or facilities. It was proposed that measures to prevent these possibilities of misuse be considered for each of the following stages in the production and use of atomic energy for peaceful purposes: uranium and thorium mines, concentration plants, refineries, chemical and metallurgical plants, primary reactors and associated chemical separation plants, isotope separation plants, and secondary reactors.

In the course of its deliberations, the Committee heard statements from a number of technical experts who furnished information on all the important stages from the raw material to the production of concentrated nuclear fuel and on other matters. The Committee desires to express its thanks to the Canadian, the United Kingdom, and the United States Delegations which arranged for these experts to attend meetings of the Committee. A list of these experts and the topics on which they tendered information is given in Annex 8.

In the course of the Committee's work, definitions of certain types of safeguards have been formulated and have been used throughout this report. *Control* as used in this report is a general term which includes any or all types of safeguards. The types of safeguards which have been specifically defined are as follows:

1. *Accounting for materials* means the systematic measurement and reporting in prescribed form of quantities of key materials entering and leaving an establishment or installation, in process, and in storage. It includes prescription of the points at which measurements must be taken, the methods of measurements, and the manner in which the data are summarized into accounts. Accounting is normally accompanied by measures of analysis and auditing to ensure conformity between the accounts and the facts. Analysis may be limited to an indirect check of the accounts to test them for consistency. In order to be thoroughly effective, however, accounting for materials must also be extended to direct and simultaneous auditing checks of the accuracy with which individual measurements are incorporated into summary accounts and the validity of the measurements themselves. This necessitates adequate independent observation of the measurements, tests of the accuracy of scales and other measuring instruments, and possibly independent duplicate measurements either on a sampling basis or as a whole. It also implies the right to obtain explanations of discrepancies. When auditing is extended to independent direct checks, it becomes one element in inspection.

2. *Inspection* means close and careful independent scrutiny of operations to detect possible evasions or violations of prescribed methods of operation. In addition to direct auditing measures as

described above, inspection may include observation of points of ingress to and egress from an establishment or installation to ensure that materials and supplies are flowing in the prescribed manner, observation of the activities within the establishment or installation, and measures in the form of aerial or ground survey and otherwise to guard against clandestine activities. To be fully effective, the power of inspection may require that the operations be carried on in a specified manner in order to facilitate the inspection. In this event, inspection verges on supervision.

3. *Supervision* means continuous association and cooperation in day-to-day operations with the management, together with authority to require that the management comply with certain conditions so as to facilitate the execution of measures of control. For example, it may include the right to require that plants be designed and constructed in such a manner as to hinder diversion of materials, the right to require that the processes be conducted in a specified manner, or the right to order cessation of operations to take a complete inventory of materials in process. The more extensive the intervention of the supervisors into such matters, the closer supervision approaches management itself.

4. *Management* means direct power and authority over day-by-day decisions governing the operations themselves as well as advisory responsibility for planning. Managerial control means internal control of a plant by a director or manager. Management by the international control agency means that the management is established by and is responsible to such an agency. Management is normally a prerogative of ownership but need not imply ownership.

5. *Licensing* is a type of safeguard in which the degree of control is determined by the licensing agreement. It means the granting of permission to conduct certain activities under specified conditions. The conditions may include accounting and reporting requirements, rights of inspection or supervision, conformity with approved plant design or processes, etc. Similar results may be obtained through the leasing of establishments or installations from the international control agency or through a management contract, where the conditions are specified in the lease or contract, but leasing is not a prerequisite of licensing.

As explained above, Committee 2 has stressed the specific types of safeguards which should be applied at the several stages in the production and utilization of atomic energy. By this method, the Committee has sought to reach conclusions concerning individual elements of control. While this method is a logical one and enables a study to be made of the separate parts of the problem, the findings thereby arrived at must be viewed in the light of the general objective of securing an effective and enforceable system of control. The detailed findings contained in Chapters 2 to 8, inclusive, are interrelated. The coordination of safeguards is discussed to some extent in Chapter 8, but further measures of coordination must be considered before formulating a comprehensive system of control.

The specific control measures mentioned in the findings are not meant to be definitive but rather to be indicative of the various types of safeguards applicable at each stage. In devising a definite system of control, provision must be made for flexibility in adapting safeguards to a rapidly developing technology. The findings are, moreover, of a technical nature. It has been assumed in the preparation of the report that the staff of the international control agency would be technically competent and loyal to the agency and that it would exercise its functions thoroughly but without encroaching on matters beyond the requirements of the implementation of its mission. It has been assumed, furthermore, that the agency would treat with the necessary discretion information which it acquires.

In considering the types of safeguards to be applied at particular points, the objective has been to provide effectiveness of control with the least interference in normal activities. An ineffective system of control would be worse than none. The interference in a country's normal activities introduced by an effective system of control would be small compared with the disturbances which would result from the defense measures necessary for protection against atomic weapons.

In the preparation of this report there has been no discussion of the type or character of the international control agency in which control authority is to be vested. The over-all powers required by an authority depend upon the functions entrusted to it. Only the functions of providing safeguards against diversion from declared establishments and of discovering clandestine operations have been considered. The question of seizure of atomic energy establishments or materials by a nation intending aggression has only been recognized as a problem for future consideration. The findings, therefore, do not represent a plan for atomic energy control but only some of the elements which should be incorporated in any complete and effective plan.

(A Summary of Findings on Safeguards is included in Part II.)

FIRST REPORT OF THE UNITED NATIONS ATOMIC ENERGY COMMISSION

(Chapters on Safeguards)

Chapter 2: Safeguards Necessary To Detect and Prevent the Diversion of Uranium and Thorium From Declared Mines and Mills

Introduction

In the general problem of safeguards, the mines and ore deposits occupy a special position. A complete control at this stage would give a starting point from which it might be possible to keep track of potentially dangerous material through all its later stages. In this connection, the report of the Scientific and Technical Committee states:

"A special significance must be attached to the devising of adequate safeguards against the diversion of raw materials, since none of the subsequent operations can proceed without uranium, or uranium and thorium."

Findings for Mining and Milling of Uranium

1. In considering the diversion of uranium at the mining and milling stage, one need only be concerned with substantial quantities of material. Occasional petty theft by miners or mill operatives would not be a matter of consequence.

The diversion of many tons of ore would be required to make a few pounds of the finished nuclear fuel.

2. Safeguards to prevent diversion should be determined, to some extent, by the richness of the ore mined. They should be stringent at rich mines and might be less strict for low-grade deposits.

The uranium content of ores varies considerably, ranging from very rich uranium ore to deposits containing small fractions of one percent of uranium. When considering the latter, the following points should be kept in mind:

Ores with a low uranium content are sometimes found in deposits which can be worked by open-pit methods. This means that operations may be scattered over a wide area, and such controls as could be set up at points of egress (e. g. from a mine shaft) would not be possible, unless the whole area were under guard and, if feasible, enclosed. It is probable that in the future substantial amounts of uranium will be derived from very low-grade ores containing other valuable elements. Clearly more rigorous safeguards would become necessary as the uranium becomes concentrated. One must also not overlook dumps of tailings from various mines, mills, and even from certain chemical plants, because these, too poor to have been worked so far for uranium, might contain a very appreciable total amount of this metal.

Knowledge of ore reserves in certain known mines would be a further safeguard against diversion. However, in most mines, sampling methods to prove ore reserves would be inaccurate and difficult to apply as a control measure.

3. The system of accounting, guarding, and inspection of uranium mines and mills could follow the normal patterns ordinarily used in the control of mining and milling operations.

Assuming that egress from the mines or mills is under control by guards checking the contents and destination of shipments, it would appear that substantial or systematic theft of ores or concentrates would probably be detected.

In addition to the physical guarding of its property, management normally has a system of control in its plants to ensure efficient operation. The controls used by the management are designed primarily with a view to detecting technical inefficiencies and ensuring and maintaining maximum recovery. They give a very close check on the flow of material over a long period of time, though they may be inaccurate over short periods.

Adequate facilities for weighing, assay, and analysis are required by the inspectorate. In the simplest case of inspection, the operating controls used by the mine and mill management could be examined and verified with comparative ease by the inspectorate. Under other circumstances, it might be necessary to duplicate controls by having a completely independent and reliable assaying and sampling laboratory. One such laboratory could service a number of mines and mills.

4. An adequate system of inspection could be so organized as not to interfere seriously with normal mining and milling operations.

Inspection of mines and mills is not a new problem but one that has been solved satisfactorily by government authorities inspecting managements to prevent the diversion of the raw materials under government control. It has been proved possible for an independent inspectorate to review the accounting procedures used by the management, check the weighing and assaying equipment, make independent observations, etc., without seriously hampering the management. Experience of this kind has been particularly in the field of precious minerals where very small diversions are important; inspection to detect large-scale diversions should be even less of an interference.

5. The inspectorate must have unrestricted access to all equipment and all phases of the operations and have facilities for independent weighing, assay, and analysis.

It is clear that its complete independence of the local management must be unquestionable.

6. The number of guards and inspectors required for uranium mines and mills would not be great as compared with the operating staff.

The duties of the inspectors would require varying degrees of technical skill and could not be regarded as purely police functions. Persons could be regarded as qualified to serve as the head of a mine or mill inspectorate if, in addition to professional training and experience as engineers, they were given a short course of special instruction.

7. The comparison of weights and assays of the shipped material at the exit from the mill and on arrival at destination would provide a necessary check on possible diversion in transit.

Such checks are normally carried out in mining and refining and would be all the more important in the case of uranium concentrates.

Summary

Adequate safeguards against diversion from declared mines and mills are possible by a system of inspection, including guards, similar to normal managerial operating controls, provided that the inspectorate has unrestricted access to all equipment and operations and has facilities for independent weighing, assay, and analysis.

Findings for Mining and Milling of Thorium

1. The danger inherent in the diversion of thorium is less immediate than in the case of uranium.

Thorium cannot be used by itself for the production of atomic energy; it requires reactors which also use natural uranium or nuclear fuel.

2. The control of thorium would be in some respects more difficult than in the case of uranium.

The most common occurrence of thorium is in monazite sands; and the great extent of some deposits, which may be scattered over hundreds of miles, together with the relatively simple equipment required, makes illicit removals relatively easy. In view of the generally low content of thorium in the sands, however, only a large quantity of material would be significant, and frequent or large-scale illicit operations would probably be readily discovered.

3. Controls for thorium could still be of the same type as those for uranium.

The problems involved in the control of diversion from declared thorium deposits are fundamentally the same as those met in the control of uranium. A system of inspection applied to operations for extracting monazite from sands could follow the same general pattern of material accounting by technical methods together with guards to check shipments and prevent unauthorized removal.

The guarding and patrolling at monazite sand deposits would be relatively more important than in the case of most uranium occurrences.

Summary

Effective control of the raw material and concentrates of thorium is possible through a system of inspection similar to that found adequate for uranium.

Chapter 3: Safeguards Necessary To Detect and Prevent the Diversion of Uranium and Thorium From Declared Refineries and Chemical and Metallurgical Plants

Introduction

In connection with the problem of safeguards at refineries and chemical and metallurgical plants, the report of the Scientific and Technical Committee states:

"Only the application of very close and careful safeguards would provide an adequate assurance against the diversion from those plants of purified chemical compounds of natural uranium or thorium for the surreptitious production of explosive material for atomic weapons."

Findings

1. Total diversion to be dangerous would still be measured in terms of tons, but, because of the greater purity of the materials involved, the quantities concerned would be smaller than in the mining and milling stages.

2. An adequate system of inspection of uranium refineries and chemical and metallurgical plants could follow the normal patterns ordinarily used in the control of similar industrial operations.

As in the case of mines, a system of guards should be provided to control egress from the plant and to check the content and destination of shipments.

Methods of assay and measurement as a basis of accounting have been so developed that at some refineries and chemical and metallurgical plants the uncertainty (technically, the "probable error") on the balance sheet assessed over a period of about a year can be kept by good management to about one percent of the material entering the plant. It is possible in such plants to make a material balance with this accuracy at any time by a clean-up of the material undergoing processing. This naturally interrupts operations, but could reasonably be required at regular intervals and in addition whenever the suspicion of diversion arises. Without a clean-up the uncertainty in the balance over periods of about a month may be several times as great and may vary widely.

Facilities for independent assay and analysis would be part of any inspection system. These might take the form of a central laboratory serving a large number of different plants.

3. An adequate system of inspection could be so organized as not to interfere seriously with normal refining and chemical and metallurgical operations.

As in the case of mines, this kind of inspection is not a new problem but one that has been met and solved in commercial practice.

It is a matter of common practice for the management to shut the plant down at intervals and clean the material out of the various stages of the process. This enables a more accurate accounting to be made of the flow of material through the plant.

An additional safeguard, applicable only to refineries treating the ore concentrates, is a cross-check by comparison of the uranium balance with the balance of radium.

4. The inspectorate must have unrestricted access to all equipment and all phases of the operations and have facilities for independent weighing, assay, and analysis. It must also have the right to require the plant to be shut down for purposes of clean-up and accounting at appropriate times, and also to require efficient operating procedure, assuming to this extent a supervisory character.

5. The number of guards and inspectors required would not be great as compared with the operating staff.

The duties of the inspectors would require varying degrees of technical skill and could not be regarded as purely police functions.

A person could be regarded as qualified to serve as the head of the inspectorate of a refinery, chemical or metallurgical plant if, in addition to having a suitable professional degree and experience, he were given a few months of special instruction.

6. The comparison of weights and analysis of the shipped material when leaving refineries or chemical and metallurgical plants and on arrival at destination would provide a necessary check on possible diversion in transit.

Such checks are normally carried out in dealing with chemicals and would be all the more important in the case of pure uranium metal or compounds.

Summary

Adequate safeguards against diversion from declared refineries and chemical and metallurgical plants are possible by a system of inspection, including guards, similar to normal managerial operating controls, provided that the inspectorate has unrestricted access to all equipment and operations and has facilities for independent weighing, assay, and analysis and provided that it has the right to require the plant to be shut down for purposes of clean-up and accounting at appropriate times and to require efficient operating procedure.

At these stages, there is no fundamental difference between the processes for thorium and for uranium.

Chapter 4: Safeguards Necessary To Detect and Prevent the Diversion of Uranium From Declared Isotope Separation Plants

Introduction

The separation of U–235 from natural uranium and the enrichment of the U–235 content of natural uranium may play an important part in the peaceful use of atomic energy.

Although it is possible that many different processes may be devised for the separation of the isotope U–235 from naturally occurring uranium, existing plants fall into two main groups:

(*a*) Electromagnetic separation plants
(*b*) Plants based on diffusion processes

Isotope separation plants may increase the concentration of U–235 in uranium in varying degrees including that necessary for direct use in an atomic weapon. The necessity for adequate safeguards against diversion presents itself therefore, in these plants, in an acute form.

In this connection, the report of the Scientific and Technical Committee states:

"Production of nuclear fuels is the crucial stage in the operations. . . . Separation plants for the production of uranium enriched in U–235 . . . deliver nuclear fuel which, under proper conditions, may be used directly for the manufacture of atomic weapons. . . . If, therefore, the strictest safeguards are not taken to prevent the material in the installations producing nuclear fuel from being diverted, the danger is extremely serious."

Findings

1. Present electromagnetic and diffusion separation plants have in common the following features which are of importance in determining the necessary safeguards:

- (*a*) The complexity and large extent of plants capable of separating significant quantities of U-235
- (*b*) The large amount of material at any time in various stages of concentration in the plants
- (*c*) The difficulty, under the presently available methods of measurement and with present processes, of any strict accounting of U–235 between the input and output materials
- (*d*) The large staff required to operate the plants
- (*e*) The absence from the plants of the radiation hazards which provide natural safeguards in certain phases of the operation of reactors.

2. The nature of the plants and the kind of processes to which the material is subjected do not preclude the application of adequate safeguards.

3. The necessary close supervision of the processes and the necessary security measures could only be provided by managerial operation by the international control agency of the whole plant.

Summary

At present, it is not possible to place reliance on the method of obtaining a material balance of uranium isotopes in the case of isotope separation plants. This is one of the important reasons why there must be internal control of such plants by a director or manager and why the management must be established by and responsible to the international control agency. Even if the material balance could be greatly improved, the inherent danger of the operation would still require management by the international control agency.

Chapter 5: Safeguards Necessary To Detect and Prevent the Diversion of Uranium, Thorium, and Plutonium From Declared Nuclear Reactors and Associated Chemical Extraction Plants

Introduction

Reactors may vary greatly in size and design. Present reactors include the large units at Hanford, designed for the production of plutonium from natural uranium, and small reactors for research purposes. Other reactors may be designed primarily for the production of power but may produce nuclear fuel as well.

The chemical plants associated with reactors are for the extraction of the fissionable and radioactive materials produced in the reactors and therefore they introduce the problem of safeguards against the diversion of materials which, even in relatively small quantities, could be used for the immediate manufacture of atomic weapons.

In this connection, the report of the Scientific and Technical Committee states:

"Production of nuclear fuels is the crucial stage in the operations. . . . the reactors and extraction plants for the production of plutonium or U–233 deliver nuclear fuel, which, under proper conditions, may be used directly for the manufacture of atomic weapons. . . . If, therefore, the strictest safeguards are not taken to prevent the material in the installations producing nuclear fuel from being diverted, the danger is extremely serious."

Available information indicates that the utilization of U–233 as nuclear fuel, which can be made from thorium by neutron absorption, though less thoroughly explored than that of plutonium, is theoretically possible. It is believed that safeguards similar to those for uranium and plutonium would be required for thorium and U–233.

Some types of secondary reactors use feed material which is so enriched that it must be very closely safeguarded. Except in this respect, primary and secondary reactors which produce nuclear fuel present similar control problems.

Findings

1. The preparation of natural uranium in an appropriate form for insertion in reactors requires safeguards similar essentially to those for the preceding chemical and metallurgical plants.

2. The international control agency must ensure that no uranium or thorium is surreptitiously placed in or around the reactor.

Uranium or thorium surreptitiously placed in or around the reactor would absorb excess neutrons and thus generate fissionable materials which might escape detection.

3. The injurious radiations from fission products provide a natural assistance to safeguarding against diversion of slugs from the time they are exposed to the neutrons in a working reactor until the radioactive fission products are removed in the chemical extraction plant.

Unless they were transported in containers of conspicuous weight and bulk, slugs which have been in the reactor for any length of time would emit radiations which would be both easy to detect and likely to be fatal to those attempting diversion.

4. The international control agency should supervise the design of the reactors and their associated chemical extraction plants to the extent necessary to preclude features that would make safeguards against diversion difficult. It should also see that construction proceeds according to design.

It is possible otherwise that devices might be put in place during the construction of the reactor or plant through which slugs might be withdrawn with comparative safety.

5. The international control agency should continuously obtain all relevant information on the operation of the reactor by observation and measurement.

This information should include data on the reactor's characteristics and performance, in order that estimates can be made of the amount of plutonium produced and in order that misuse of the reactor can be detected.

6. The diversion of nuclear fuel during the purification process would be extremely grave and might be very difficult to detect.

Diversion becomes easier as concentration is completed and purification proceeds because both the bulk and radioactivity of the material are decreased, making detection more difficult and diminishing the hazard to those engaged in illicit work.

7. As now in operation, the extraction procedure is such that the diversion of purified nuclear fuel might be camouflaged as normal operating losses.

The amount of nuclear fuel in the slugs cannot be accurately determined to begin with, and the losses during chemical treatment introduce further uncertainties. The task of control would be facilitated if, in the future, methods for establishing an accurate balance sheet could be developed.

8. Diversion of purified nuclear fuel is difficult to detect. Assurance against such diversion, therefore, requires that the international control agency itself carry out the functions of management in the case of chemical extraction plants.

9. The international control agency must establish the strictest possible safeguards against diversion of highly enriched or pure nuclear fuel during processing, storage, and shipment.

The nuclear fuel in these conditions is in its ultimate form and can be put to use in an atomic weapon within a few days.

10. From the nature of things, it is not possible at the present moment to decide in a general way the type of control which will offer adequate safeguards against diversion from reactors, but, in many cases, management by the international control agency may be the only adequate safeguard. Secondary power reactors may be fully as dangerous as primary reactors of equivalent capacity, since either may be used to produce nuclear fuel.

11. Satisfactory safeguards in the case of small reactors for research purposes and their associated chemical plants could be provided by a system of licensing and periodic inspection by the international control agency.

Small reactors for research purposes are those not capable of producing nuclear fuel at a rate significant for military purposes. More stringent safeguards might be required where a number of such reactors with a large total content of nuclear fuel or a large potential production exist in any country, or territories under the same national jurisdiction, since a number of these reactors in combination may be fully as dangerous as a large reactor.

Summary

A. At present, it is not possible to place reliance on the method of obtaining a material balance of plutonium in the case of reactors and associated chemical extraction plants. This is one of the important reasons why the chemical extraction plants and, in some cases, the reactors should be subject to internal control by a director or manager and why the management must be established by and be responsible to the international control agency. Even if the material balance could be greatly improved, the inherent danger of the operations would still require management by the international control agency.

B. The safeguards required for the control of reactors will depend on their size and design and especially on their content and possible rate of production of nuclear fuel. The safeguards available to the international control agency should include licensing and inspection, supervision, and management of the operation of reactors. In addition, close supervision of the design and construction of reactors is essential in all cases.

C. Periodic inspection together with licensing is an adequate safeguard in the case of small research reactors and their associated chemical plants, unless their total content of nuclear fuel or potential rate of output in any area is of military significance.

D. Adequate safeguards for chemical extraction plants associated with all except small research reactors are only possible through management by the international control agency.

E. Adequate safeguards during the preparation of high-grade or pure nuclear fuels in a suitable form for insertion in secondary reactors, and, during the storage and shipment of such fuels, are only possible through management by the international control agency.

Chapter 6: Safeguards Necessary To Ensure the Detection of Clandestine Activities

Introduction

Like all problems in atomic energy, the detection of clandestine operations is greatly simplified by the technical facts of the field. Nevertheless, general and political considerations play a larger part in the effectiveness and acceptability of any system for the detection of clandestine operations than in most other parts of the problem. Thus, any form of general inspection by an international control agency raises problems which are beyond the scope of this present enquiry. They will need most careful consideration when the functions, powers, and organization of the agency are defined. It will be here that the conflicts between the requirements of the international control agency on the one hand and considerations of national sovereignty and present practice on the other will have to be resolved. Throughout this chapter of the report, we shall not always state, but shall always assume, that adequate restraints have been provided against the abuse by the international control agency of the wide powers which it must necessarily be given and that it will conduct its activities in conformity with the established regulations.

Measures for the detection of clandestine operations in the realm of atomic energy must be based on information from a variety of sources coordinated and evaluated by a central agency. The control of declared activities will itself provide much useful information. This information, combined with geological data, aerial and ground surveys (see note of Professor Alexandrov in Finding 5), and pericdic reports on specified subjects, will aid in directing attention to areas and operations which might be involved in clandestine activities.

It is essential that, within properly defined limits the international control agency be granted freedom of travel, the right of access for inspection, and the right to conduct aerial or ground surveys, if there is to be assurance that clandestine activities on a significant scale will be found. Reasonable and proper use of these rights is necessary to avoid undue interference with activities unrelated to atomic energy, and appropriate restraints are necessary. Even so, it seems inevitable that any system of inspection adequate to ensure the detection of clandestine activities will result in knowledge and inspection of activities unrelated to atomic energy. Particular restraints should therefore be provided against the misuse or disclosure of information secured by the international control agency in the course of its activities.

It appears impracticable and undesirable to attempt the routine inspection of the total industrial operations of a nation in order to detect possible clandestine activities in the realm of atomic energy. Consequently, the problem of detecting clandestine operations at stages subsequent to mining and milling involves, first, the establishment of reasonable grounds for suspecting clandestine operations in a particular plant or area, and, second, the direct inspection of buildings and installations to the extent necessary to resolve reasonable doubts. Stringent safeguards against clandestine mining and milling operations, together with strict control against diversion from authorized activities at all stages, will reduce the necessity for extensive inspection of ordinary manufacturing and processing installations, in which interference would be most irksome.

Findings

1. The right of authorized personnel of the international control agency to direct access and inspection, subject to appropriate restraints, and the right to travel without restraint are essential in the detection of clandestine activities.

Direct inspection is the most reliable means of detecting clandestine activities; hence, the right of inspection wherever suspicion exists constitutes an important safeguard. It would in general be necessary to require that demonstrable grounds for suspicion exist as a justification for inspection and to establish reasonable legal procedures for the regulation of inspection. The procedures must not delay legitimate access by the international control agency. However, there are activities and installations which are so closely linked to atomic energy activities or so readily converted to such activities that their existence *per se* is cause for suspicion and justification for inspection. This includes all mining operations in areas known or likely to contain uranium or thorium in significant amounts. It includes chemical or metallurgical plants processing concentrates which contain even small proportions of uranium or thorium. It includes also certain types of industrial installations, and these should be specified.

2. The character and scale of operations using known processes for the production of significant quantities of nuclear fuels provide useful indications of their existence.

Some of the signposts which point to the existence of these operations are:

(*a*) Mining operations must be substantial.

(*b*) Large or characteristic installations are required in the case of isotope separation plants, primary reactors, and chemical extraction plants.

(*c*) Large amounts of power are required for isotope separation plants.

(*d*) Large quantities of fresh water are required, principally as a cooling medium, in the case of certain reactors. Consequently, such plants are likely to be located on rivers or lakes.

(*e*) In the case of reactors and associated chemical extraction plants, radioactive wastes are produced.

(*f*) Extensive shielding against radiation is required in the case of reactors and associated chemical extraction plants.

The above signposts apply to present types of plants. Rapid technical developments and changes in processes are to be expected, but there is no technological basis for expecting that developments of the next several years will permit the use of installations which are not large enough relative to other industrial installations to attract attention. The importance of this consideration lies in the fact that the size of the installations is the best guarantee that their existence in suspected areas could be detected by aerial surveys. It might be possible to subdivide certain operations in an effort to escape detection, but this would entail an increased number of installations.

3. The international control agency would need periodic reports from States on categories of information directly related to the production and use of atomic energy. Certain ancillary information would also be desirable.

Categories of information on which States should submit reports include:

(*a*) Geological formations in which uranium and thorium might occur.

(*b*) Mining operations large enough to be potential sources of uranium or thorium.

(*c*) Production shipments, location, and use of specialized equipment and supplies such as:

Mass spectrometers,
Diffusion barriers,
Gas centrifuges,
Electromagnetic isotope separation units,
Very pure graphite in large amounts,
Heavy water, and
Beryllium or beryllium compounds in large amounts.

Categories of information which would be desirable include:

(*a*) Large engineering construction.
(*b*) Large producers or consumers of heat or electricity.

4. The international control agency should coordinate the available information and thereby determine what areas and installations require further inspection to resolve reasonable doubt that they contain clandestine activities.

Information of value in the detection of clandestine activities will become available to the international control agency in the course of its control of declared activities.

Information about activities in specific areas could be secured by an appropriate combination of aerial and ground surveys (discussed in Finding 5).

General information related to the production and use of atomic energy could be provided by a system of periodic reports from all national governments (discussed in Finding 3).

Although no one of these types of information alone provides complete assurance that clandestine activities would be detected, the correlation of such information provides a guide to areas and activities requiring direct inspection for clandestine operations.

5. Aerial surveys combined with ground surveys and direct inspection are essential in some circumstances for the detection of clandestine operations.

Aerial surveys are essential in some circumstances to the detection of clandestine operations in areas difficult of access or sparsely populated. The international control agency must therefore be granted the right, under appropriate limitations, to conduct such surveys. In some cases, it will be necessary for the agency to have the permanent right to conduct periodic aerial surveys over areas where uranium and thorium ores are known, or likely, to be found. Air surveys should also be authorized in other cases where grounds for suspicion of clandestine operations are shown in accordance with the procedural requirements referred to in Finding 1.

As a source of information, aerial photography provides a record that is factual, objective, definite, and permanent. Moreover, aerial surveys reduce the time and cost of securing information, especially in examining large areas for unreported mining activities.

(Note: During the course of the discussion of the proposals concerning the detection of clandestine activity by means of aerial photography and ground surveys, Professor Alexandrov (U.S.S.R.) stated that the proposals under discussion did, to a great extent, touch more on economic and other spheres not related to atomic energy than on the question of the detection of clandestine activity in the mining and refining of uranium and thorium ores. On this basis, Professor Alexandrov declined to participate in the discussion of those sections of the document dealing with this type of detection.)

Aerial surveys constitute one source of information about geological formations. The completeness of this information varies with the character of the terrain but must ordinarily be supplemented by ground surveys. Aerial surveys have been used successfully to locate areas in which the occurrence of uranium ores appeared probable, and was later confirmed by ground exploration.

Periodic aerial surveys of areas known, or likely, to contain uranium or thorium ores can readily discover the existence of mining operations. Ground inspection would be required to determine the products of the mines.

Aerial surveys are particularly useful for determining the existence or non-existence of industrial installations in an area in which clandestine activities are suspected. The interpretation of aerial photographs of highly industrialized areas is more difficult than in the case of non-industrial areas, but may be a fairly reliable guide in either case. Aerial photographs give considerable information about the general character of the operations conducted in an installation: power requirements; water requirements; and the flow of raw materials and products. However, direct ground inspection is necessary to determine accurately the character of the operations.

New installations, or extensive modifications in existing installations, are readily detectable by comparison of aerial photographs taken at successive intervals.

Camouflage is not very effective against photographic aerial survey but makes it difficult to determine the nature of the installations under observation.

6. Ground surveys are a useful means for the detection of clandestine operations; under certain conditions, the right to conduct such surveys is essential.

The principal objectives of ground surveys would be to locate mines and large industrial buildings, to conduct geologic surveys, to make physical measurements useful in locating clandestine activities (such as seismic measurements to detect blasting), and to sample materials for radioactive elements.

In crowded, built-up areas, ground surveys will ordinarily provide a satisfactory and reasonably convenient means for determining the existence or non-existence of operations which warrant direct inspection. Generally speaking, investigation by ground parties would be likely to pick up less irrelevant information than investigation by aerial surveys. Moreover, certain types of installations cannot be investigated adequately from the air. Examples range from underground structures and installations located in densely wooded areas to ordinary industrial buildings which may be detected with ease, but without reliable indication of the activities involved. Direct inspection may not be required if ground investigation discloses no basis for suspicion.

Ground surveys can be conducted with maximum efficiency if aerial surveys are available as an indication of the areas and installations which warrant attention, as well as the areas which can be ignored without appreciable risk.

The right to conduct ground surveys is essential, but should be subject to appropriate restrictions similar to those required for inspection.

7. Safeguards against the dangers of clandestine mining would be provided by the right of inspection coupled with air and ground surveys based on adequate geological knowledge. Neither air survey nor ground survey alone provides adequate information; both are essential and they must be used in combination.

All available geological knowledge, whether acquired directly or indirectly, is needed by the international control agency to determine the areas to which air and ground surveys should be directed for the detection of possible clandestine mining and milling. Aerial surveys of such areas, which should be provided for in accordance with Finding 5, will ordinarily reveal any unreported operation, or changes in a known installation, but will not usually indicate the character of the operations. Ground surveys may be required in areas not readily evaluated by aerial photography, e.g. heavily wooded areas or caves.

It is assumed that all declared mines producing uranium or thorium would be under controls designed to prevent the diversion of these materials. All other mines would have to be inspected at appropriate intervals to make sure that they did not produce uranium or thorium as by-products, except where the geological formations exclude the possibility of uranium or thorium deposits.

In areas where the occurrence of uranium or thorium is known or probable on the basis of geological information, periodic aerial surveys could provide an adequate check on the existence of unreported mining operations. However, the character of these operations could only be determined by inspection at the mine and sampling of the ore and the products from the mine.

The detection of suspected clandestine mining operations might, on occasion, be facilitated by inspection of transportation facilities and materials being transported to or from areas known, or likely, to contain uranium or thorium deposits. In some cases the means of transportation required for unreported operations located in remote areas would provide an indication of the existence of activity of an unknown character. In cases involving transportation by water or by hydroplane, the usefulness of this method of detecting possible clandestine activities may be quite limited.

8. Clandestine refineries and chemical and metallurgical plants may not differ from conventional chemical processing plants to a degree which would aid in their detection.

Plants for the chemical and metallurgical treatment of uranium and thorium concentrates need not be so large as to attract attention. While the existence of these plants probably could be detected by aerial surveys if they were conducted, there would be little to indicate that they were engaged in clandestine operations. However, these plants alone would not constitute a serious threat, since their product would have to be fed into isotope separation plants or reactors which do have distinguishing characteristics.

9. The detection of clandestine bomb manufacture as such is almost impossible; it is therefore vital that any unauthorized accumulation of essential nuclear fuels be prevented.

Plant installations for the manufacture of bombs are small compared with those required for the production of nuclear fuels, and they have no distinguishing features to facilitate detection. As long as bomb design requires an unusual quality and variety of research personnel, the activities of such personnel might indicate where bombs were being produced clandestinely; however, once the design of atomic weapons had been developed, the need for scientific personnel would be reduced and the value of a knowledge of the activities of key personnel would therefore be slight. Because of the difficulties in detecting clandestine bomb manufacture and because of the extremely short time and small facilities required to produce the bomb if the necessary fissionable material is available, it is essential that stringent safeguards be taken at earlier stages. Accordingly, the prevention of clandestine bomb manufacture must begin with the establishment of safeguards against diversion and clandestine production of raw materials and must be applied at all stages in the production and use of fissionable material.

Summary

A. The international control agency will require broad privileges of movement and inspection, including the rights to conduct surveys by ground and air. These privileges should, however, be very carefully defined to ensure against misuse.

B. Reports and returns on relevant matters will be required from national governments.

C. The international control agency should coordinate all relevant information to determine what areas may be suspected of containing clandestine activities.

D. Isotope separation plants, reactors, and chemical extraction plants, as well as mines, have distinguishing features which would facilitate the detection of clandestine activities at those stages.

E. Detection of clandestine refineries and chemical and metallurgical plants is more difficult than detection of clandestine operations at other stages in the processing of nuclear fuel.

F. The detection of clandestine bomb manufacture as such is almost impossible; it is therefore vital that any unauthorized accumulation of essential nuclear fuels be prevented.

Chapter 7: Safeguards Against the Seizure of Atomic Energy Establishments or Materials

Seizure means the overt removal of declared peaceful activities from the exercise of effective authority by the international control agency. The seriousness of seizure of atomic plants and materials would depend on the stage in the production of nuclear fuels at which seizure occurred. The relative dangers of the material at various stages have been considered and are set forth in the earlier findings. The problem of erecting safeguards against the dangers from seizure is before the Commission, but has not yet been given more than preliminary consideration. However, it is possible at this time to indicate the scope of the problem and some of the considerations involved.

The agreed finding of the Scientific and Technical Committee in this connection, as stated in its report, is:

> "We have been discussing the possibilities of clandestine diversion of materials from the peaceful activities in the domain of atomic energy, but we must not overlook that with certain systems of control one would have to consider the possibility that plants or materials might be seized. This implies a danger, the seriousness of which would be greatest in the case of seizure of stocks of concentrated nuclear fuel, because from that stage weapons could be produced most quickly and in relatively small plants. Next in order of seriousness would be the seizure of plants producing nuclear fuels. A wide geographical dispersal of stocks and plants and the restriction of stocks to minimum operating levels would reduce the risk that a large quantity would be involved in a single seizure. Seizure of mines or of facilities at other early stages would only be of advantage to those desiring to make weapons if they had at their disposal a plant capable of producing nuclear fuel."

Political and general considerations are paramount in the matter of safeguards against seizure. No technical measures are likely to prevent seizure by a nation that has determined upon aggression and such measures as could be administered by an international control agency could hardly give complete satisfaction from the point of view of safety. There may, however, be some measures of a technical nature which could be applied through an international control agency; these measures would assist in forestalling seizure and would tend to minimize the military advantages that an aggressor could expect from seizure.

The nature of the evidence reviewed by the Commission to date suggests that its further deliberations on the subject of seizure should include consideration of the following topics:

1. Seizure as it applies to materials and plants under different types of safeguards
2. The desirability of the geographical dispersal of plants and stocks of materials
3. The possibility of the reduction of inventories of materials in process or in storage

4. The possibility of making the materials for power unsuitable for weapons
5. The desirability of providing for the damaging or destruction of plants before they can be seized

Summary

Problems relating to seizure have been considered thus far only in preliminary terms. The major questions of seizure are political rather than technical. It appears, however, that technical measures could reduce the military advantages and therefore the dangers of seizure.

Chapter 8: Coordination of Safeguards

Introduction

The preceding chapters of this report have discussed the safeguards required at each stage in the production and use of atomic energy to prevent the dangers indicated in the report of the Scientific and Technical Committee. In designing an effective and comprehensive system of control, attention must be given not only to the safeguards required at the several stages but also to the interrelation among those safeguards. Of particular importance in this connection is the scheduling of operations at successive stages in such a way that stocks of dangerous material are kept to a minimum.

The coordination of safeguards raises further important questions as to the nature, organization, and powers of the international control agency responsible for the control of atomic energy. Preliminary investigations have indicated that, when considering the powers of the international control agency, further attention will have to be given to the interrelations among controls at various plants and the degree of control over uranium and thorium through all of the processes. These subjects have not as yet been considered by the Committee.

Findings

1. In addition to material accounting at each individual step in atomic energy processes, the international control agency should provide for material accounting checks between points of shipment and receipt of material as a means of detecting possible diversion in transit.

2. The international control agency should control the storage and shipment of uranium and thorium materials to the degree necessary for security purposes.

3. The international control agency should itself store and itself handle all enriched or pure nuclear fuel in transit. This does not necessarily imply ownership either of the materials or of the transit or storage facilities, questions which have not yet been discussed.

4. Since stocks of concentrated or pure nuclear fuel are acutely dangerous, operations at successive stages in the production of atomic energy should be so scheduled that stocks of materials in transit and in storage are minimized, but without interfering unduly with the development and effectiveness of peaceful activities.

STATUTE OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

(Excerpt)

STATUTE OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

ARTICLE I

Establishment of the Agency

The Parties hereto establish an International Atomic Energy Agency (hereinafter referred to as "the Agency") upon the terms and conditions hereinafter set forth.

ARTICLE II

Objectives

The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

ARTICLE III

Functions

A. The Agency is authorized:

1. To encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world; and, if requested to do so, to act as an intermediary for the purposes of securing the performance of services or the supplying of materials, equipment, or facilities by one member of the Agency for another; and to perform any operation or service useful in research on, or development or practical application of, atomic energy for peaceful purposes;

2. To make provision, in accordance with this Statute, for materials, services, equipment, and facilities to meet the needs of research on, and development and practical application of, atomic energy for peaceful purposes, including the production of electric power, with due consideration for the needs of the under-developed areas of the world;

3. To foster the exchange of scientific and technical information on peaceful uses of atomic energy;

4. To encourage the exchange and training of scientists and experts in the field of peaceful uses of atomic energy;

5. To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further

any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of atomic energy;

6. To establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property (including such standards for labour conditions), and to provide for the application of these standards to its own operations as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of atomic energy;

7. To acquire or establish any facilities, plant and equipment useful in carrying out its authorized functions, whenever the facilities, plant, and equipment otherwise available to it in the area concerned are inadequate or available only on terms it deems unsatisfactory.

B. In carrying out its functions, the Agency shall:

1. Conduct its activities in accordance with the purposes and principles of the United Nations to promote peace and international cooperation, and in conformity with policies of the United Nations furthering the establishment of safeguarded world-wide disarmament and in conformity with any international agreements entered into pursuant to such policies;

2. Establish control over the use of special fissionable materials received by the Agency, in order to ensure that these materials are used only for peaceful purposes;

3. Allocate its resources in such a manner as to secure efficient utilization and the greatest possible general benefit in all areas of the world, bearing in mind the special needs of the under-developed areas of the world;

4. Submit reports on its activities annually to the General Assembly of the United Nations and, when appropriate, to the Security Council: if in connexion with the activities of the Agency there should arise questions that are within the competence of the Security Council, the Agency shall notify the Security Council, as the organ bearing the main responsibility for the maintenance of international peace and security, and may also take the measures open

to it under this Statute, including those provided in paragraph C of article XII;

5. Submit reports to the Economic and Social Council and other organs of the United Nations on matters within the competence of these organs.

C. In carrying out its functions, the Agency shall not make assistance to members subject to any political, economic, military, or other conditions incompatible with the provisions of this Statute.

D. Subject to the provisions of this Statute and to the terms of agreements concluded between a State or a group of States and the Agency which shall be in accordance with the provisions of the Statute, the activities of the Agency shall be carried out with due observance of the sovereign rights of States.

Article IV

Membership

A. The initial members of the Agency shall be those States Members of the United Nations or of any of the specialized agencies which shall have signed this Statute within ninety days after it is opened for signature and shall have deposited an instrument of ratification.

B. Other members of the Agency shall be those States, whether or not Members of the United Nations or of any of the specialized agencies, which deposit an instrument of acceptance of this Statute after their membership has been approved by the General Conference upon the recommendation of the Board of Governors. In recommending and approving a State for membership, the Board of Governors and the General Conference shall determine that the State is able and willing to carry out the obligations of membership in the Agency, giving due consideration to its ability and willingness to act in accordance with the purposes and principles of the Charter of the United Nations.

TS 993.
59 Stat. 1031.

C. The Agency is based on the principle of the sovereign equality of all its members, and all members, in order to ensure to all of them the rights and benefits resulting from membership, shall fulfil in good faith the obligations assumed by them in accordance with this Statute.

Article V

General Conference

A. A General Conference consisting of representatives of all members shall meet in regular annual session and in such special sessions as shall be convened by the Director General at the request of the Board of Governors or of a majority of members. The sessions shall take place at the headquarters of the Agency unless otherwise determined by the General Conference.

B. At such sessions, each member shall be represented by one delegate who may be accompanied by alternates and by advisers. The cost of attendance of any delegation shall be borne by the member concerned.

C. The General Conference shall elect a President and such other officers as may be required at the beginning of each session. They shall hold office for the duration of the session. The General Conference, subject to the provisions of this Statute, shall adopt its own rules of procedure. Each member shall have one vote. Decisions pursuant to paragraph H of article XIV, paragraph C of article XVIII and paragraph B of article XIX shall be made by a two-thirds majority of the members present and voting. Decisions on other questions, including the determination of additional questions or categories of questions to be decided by a two-thirds majority, shall be made by a majority of the members present and voting. A majority of members shall constitute a quorum.

D. The General Conference may discuss any questions or any matters within the scope of this Statute or relating to the powers and functions of any organs provided for in this Statute, and may make recommendations to the membership of the Agency or to the Board of Governors or to both on any such questions or matters.

bership on the Board the five members most advanced in the technology of atomic energy including the production of source materials and the member most advanced in the technology of atomic energy including the production of source materials in each of the following areas not represented by the aforesaid five:

(1) North America
(2) Latin America
(3) Western Europe
(4) Eastern Europe
(5) Africa and the Middle East
(6) South Asia
(7) South East Asia and the Pacific
(8) Far East.

ARTICLE VI

Board of Governors

A. The Board of Governors shall be composed as follows:

1. The outgoing Board of Governors (or in the case of the first Board, the Preparatory Commission referred to in Annex I) shall designate for mem-

ARTICLE VII

Staff

A. The staff of the Agency shall be headed by a Director General. The Director General shall be appointed by the Board of Governors with the approval of the General Conference for a term of four years. He shall be the chief administrative officer of the Agency.

B. The Director General shall be responsible for the appointment, organization, and functioning of the staff and shall be under the authority of and subject to the control of the Board of Governors. He shall perform his duties in accordance with regulations adopted by the Board.

C. The staff shall include such qualified scientific and technical and other personnel as may be required to fulfil the objectives and functions of the Agency. The Agency shall be guided by the principle that its permanent staff shall be kept to a minimum.

D. The paramount consideration in the recruitment and employment of the staff and in the determination of the conditions of service shall be to secure employees of the highest standards of efficiency, technical competence, and integrity. Subject to this consideration, due regard shall be paid to the contributions of members to the Agency and to the importance of recruiting the staff on as wide a geographical basis as possible.

E. The terms and conditions on which the staff shall be appointed, remunerated, and dismissed shall be in accordance with regulations made by the Board of Governors, subject to the provisions of this Statute and to general rules approved by the General Conference on the recommendation of the Board.

F. In the performance of their duties, the Director General and the staff shall not seek or receive instructions from any source external to the Agency. They shall refrain from any action which might reflect on their position as officials of the Agency; subject to their responsibilities to the Agency, they shall not disclose any industrial secret or other confidential information coming to their knowledge by reason of their official duties for the Agency. Each member undertakes to respect the international character of the responsibilities of the Director General and the staff and shall not seek to influence them in the discharge of their duties.

G. In this article the term "staff" includes guards.

ARTICLE XII

Agency safeguards

A. With respect to any Agency project, or other arrangement where the Agency is requested by the parties concerned to apply safeguards, the Agency shall have the following rights and responsibilities to the extent relevant to the project or arrangement:

1. To examine the design of specialized equipment and facilities, including nuclear reactors, and to approve it only from the viewpoint of assuring that it will not further any military purpose, that it complies with applicable health and safety standards, and that it will permit effective application of the safeguards provided for in this article;

2. To require the observance of any health and safety measures prescribed by the Agency;

3. To require the maintenance and production of operating records to assist in ensuring accountability for source and special fissionable materials used or produced in the project or arrangement;

4. To call for and receive progress reports;

5. To approve the means to be used for the chemical processing of irradiated materials solely to ensure that this chemical processing will not lend itself to diversion of materials for military purposes and will comply with applicable health and safety standards; to require that special fissionable materials recovered or produced as a by-product be used for peaceful purposes under continuing Agency safeguards for research or in reactors, existing or under construction, specified by the member or members concerned; and to require deposit with the Agency of any excess of any special fissionable materials recovered or produced as a by-product over what is needed for the above-stated uses in order to prevent stockpiling of these materials, provided that thereafter at the request of the member or members concerned special fissionable materials so deposited with the Agency shall be returned promptly to the member or members concerned for use under the same provisions as stated above;

6. To send into the territory of the recipient State or States inspectors, designated by the Agency after consultation with the State or States concerned, who shall have access at all times to all places and data and to any person who by reason of his occupation deals with materials, equipment, or facilities which are required by this Statute to be safeguarded, as necessary to account for source and special fissionable materials supplied and fissionable products and to determine whether there is compliance with the undertaking against use in furtherance of any military purpose referred to in sub-paragraph F-4 of article XI, with the health and safety measures referred to in subparagraph A-2 of this article, and with any other conditions prescribed in

the agreement between the Agency and the State or States concerned. Inspectors designated by the Agency shall be accompanied by representatives of the authorities of the State concerned, if that State so requests, provided that the inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions;

7. In the event of non-compliance and failure by the recipient State or States to take requested corrective steps within a reasonable time, to suspend or terminate assistance and withdraw any materials and equipment made available by the Agency or a member in furtherance of the project.

B. The Agency shall, as necessary, establish a staff of inspectors. The staff of inspectors shall have the responsibility of examining all operations conducted by the Agency itself to determine whether the Agency is complying with the health and safety measures prescribed by it for application to projects subject to its approval, supervision or control, and whether the Agency is taking adequate measures to prevent the source and special fissionable materials in its custody or used or produced in its own operations from being used in furtherance of any military purpose. The Agency shall take remedial action forthwith to correct any non-compliance or failure to take adequate measures.

C. The staff of inspectors shall also have the responsibility of obtaining and verifying the accounting referred to in sub-paragraph A-6 of this article and of determining whether there is compliance with the undertaking referred to in sub-paragraph F-4 of article XI, with the measures referred to in sub-paragraph A-2 of this article, and with all other conditions of the project prescribed in the agreement between the Agency and the State or States concerned. The inspectors shall report any non-compliance to the Director General who shall thereupon transmit the report to the Board of Governors. The Board shall call upon the recipient State or States to remedy forthwith any non-compliance which it finds to have occurred. The Board shall report the non-compliance to all members and to the Security Council and General Assembly of the United Nations. In the event of failure of the recipient State or States to take fully corrective action within a reasonable time, the Board may take one or both of the following measures: direct curtailment or suspension of assistance being provided by the Agency or by a member, and call for the return of materials and equipment made available to the recipient member or group of members. The Agency may also, in accordance with article XIX, suspend any non-complying member from the exercise of the privileges and rights of membership.

REPORT BY THE CHAIRMAN OF THE UNITED STATES DELEGATION

REPORT ON THE CONFERENCE ON THE STATUTE OF THE INTERNATIONAL ATOMIC ENERGY AGENCY

I. BACKGROUND

A Conference of 81 states and observers from 7 specialized agencies of the United Nations (enclosure 1) met at United Nations Headquarters in New York between September 20 and October 26, 1956, to consider the draft statute of April 18, 1956, for the International Atomic Energy Agency. The Agency was originally proposed by President Eisenhower on December 8, 1953, to foster the peaceful uses of the atom and to provide a positive new approach to the solution of international problems.

The text of the statute debated by the Conference had been drafted and unanimously adopted as a whole by the 12 states sponsoring the Conference (Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Portugal, Union of South Africa, Union of Soviet Socialist Republics, United Kingdom, United States) at a Working Level Meeting held in Washington during the winter and spring of 1956.

The United States, acting on behalf of the sponsoring group, invited all 87 members of the United Nations and its specialized agencies to the Conference, one of the largest international gatherings held to date. Previously this community of nations had had an opportunity to review an earlier draft of the statute circulated for comment by the original eight negotiating states (Australia, Belgium, Canada, France, Portugal, Union of South Africa, United Kingdom, United States) on August 22, 1955. The comment received in response was carefully studied by the Working Level Meeting in addition to views expressed on the proposed Agency at the sessions of the General Assembly of the United Nations in 1954 and 1955. Thus prior to the Conference, opportunity had been given to interested countries to have their ideas and suggestions incorporated into the draft statute of April 18, 1956.

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III. MAJOR CONFERENCE ISSUES

(a) Agency functions

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The most important amendment to article III adopted by the Conference gives the Agency enabling authority to apply its safeguard system upon request of a member state to the atomic energy activities of that state. The Agency would thus be in a position to apply its safeguards universally in the event of future agreement among countries with atomic weapon programs to safeguard their atomic energy activities against diversion to military purposes. The inclusion of this objective as a possible Agency activity helped ameliorate the fact that for the time being safeguards will be applied only to countries requesting and receiving assistance.

In U. S. Congress. Senate. Committee on Foreign Relations and Senate Members of the Joint Committee on Atomic Energy. Statute of the International Atomic Energy Agency. Hearings, 85th Congress, 1st session. May 10, 14, 15 and 20, 1957. pp. 41-46, and 60.

(d) Safeguard provisions

The extent and depth of the safeguard system contained in article XII of the draft statute proved the most controversial issue of the Conference. Two joint amendments submitted by Ceylon, Egypt, India, and Indonesia struck at the heart of the safeguard system. One would have removed source materials from Agency accountability (art. XII A–3); the other would have crippled Agency ability to prevent the accumulation of national stockpiles of weapon-grade fissionable materials produced as byproducts in Agency assisted projects (art. XII A–5). The sponsors claimed this curtailment of Agency authority in applying safeguards was necessary to prevent burdensome, unnecessary and possibly dangerous interference by the Agency in the economic growth of member states, especially the poor and undeveloped members most in need of Agency assistance. The U. S. S. R. supported these amendments, alleging that safeguard provisions as they stood were uncalled for in the absence of agreement on the abolition of nuclear weapons and that these provisions constituted an invasion of sovereign rights.

Following an extensive debate that revealed misconceptions and fears arising from some ambiguity in the language of the draft statute on the issues concerned, Canada, the United Kingdom, and the United States introduced 2 clarifying and qualifying amendments: 1 clearly limiting accountability for source materials to those used or produced in Agency projects and the other making it explicit that in deciding upon retention by member states of byproduct fissionable materials or their deposit with the Agency, the Agency should be guided by only two criteria—whether the materials were to be used for peaceful purposes and in such a way as not to endanger health and safety. These amendments had the effect of removing any possibility that the Agency would seek to judge the economic merit or technical feasibility of projects or programs when reaching decisions concerning the retention of byproduct fissionable materials.

Agreement of India and her cosponsoring states after further negotiations was finally obtained to the Canadian, United Kingdom, and United States amendment on source materials and to a mutually acceptable Franco-Swiss amendment further clarifying and defining Agency rights and objectives regarding the deposit of byproduct fissionable materials to prevent national stockpiling. In both instances, therefore, the basic principles were retained but were couched in new language aimed at dispelling fears that Agency authority would be greater than required to discharge its responsibilities and would be used to interfere beyond its competence in domestic arrangements of member states.

The adoption of a number of Swiss amendments delineating more specifically the Agency's inspection rights (art. XII A–6) also helped to allay misgivings, both among the underdeveloped countries and certain countries of Western Europe. In this connection, it was pointed out that the more technically advanced countries in Western Europe and elsewhere would be the first with programs requiring more comprehensive type safeguards. Hence underdeveloped countries would have an opportunity to observe the effect of the application of such safeguards before having to experience them.

As the result of willingness on both sides to discuss and negotiate original differences, agreement was thus achieved on unimpaired and textually improved safeguard provisions, which were unanimously approved by the Conference.

* * * *

VI. UNITED STATES PARTICIPATION AT THE CONFERENCE

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(c) United States Conference objectives and achievements

The basic United States objective was to obtain the adoption of the draft statute without substantial alteration and with the widest possible international support so as to encourage maximum membership and participation among the 87 countries eligible for initial membership. With the unanimous adoption by the Conference of an improved but basically unaltered text of the statute, this United States objective was fully attained. In achieving it, the United States followed a flexible approach based on willingness to negotiate differences or to explain and clarify issues on which it was necessary to remain firm. The success of this policy is attested to by the fact that the resulting statute not only enjoyed the broadest international approval but also should make possible the establishment and operation of an Agency that the United States can generously support on a continuing basis.

More specifically, the statute contains all those features which the United States worked to include. Functionally, it will make possible an Agency with broad authority to assist in research and development in the peaceful uses field; possess and distribute nuclear materials; carry out the pooling of such materials at the request of member states as proposed by the President; establish and operate its own facilities; organize and apply a system of minimum safeguards in the interest of health, safety, and international security; apply such safeguards on request to bilateral or multilateral arrangements or the atomic energy activities of a member state; conduct its financial management on a flexible but business-like basis in the interest of the entire membership; establish an appropriate relationship with the United Nations and other international organizations; and take into consideration recognized standards of international conduct in connection with the admission of new members. Organizationally, the statute should make possible an Agency with a technically competent but broadly representative Board of Governors responsible for the managerial operations of the Agency and responsive to the General Conference, through which the Agency membership as a whole will be able to speak in connection with the formulation of broad Agency policy.

The unusually cooperative and harmonious atmosphere of the Conference, which made these achievements possible, gives substance to President Eisenhower's hope that the Agency will provide a new and promising avenue to the solution of international problems. The success of the Conference would thus seem to assure the swift translation of the President's Agency proposal from a hopeful idea to a useful, working reality.

DECEMBER 6, 1956.

State Department answer to a question by Senator Hickenlooper

31. As a matter of fact are there any reliable safeguards that would adequately insure against either the seizure of plants and facilities by a violating nation or the diversion of atomic materials for weapons use, other than simple agreements?

The safeguards which are written into the IAEA statute are designed to prevent diversion of materials or the dangerous accumulation of unused quantities of materials. We are convinced that they will be effective and adequate for this purpose. They include such concrete measures as approval of plans and inspection and measurement of materials. These safeguards will not provide an ultimate guarantee against seizure of plants and facilities, but they will succeed in making seizure unattractive and unprofitable. Even if the unexpected occurred, since the material which might be seized or diverted would not be immediately usable for military purposes, the Agency safeguards system provides an effective alarm system against aggressive intentions which would be lacking if the Agency did not exist.

INTERNATIONAL ATOMIC ENERGY AGENCY PARTICIPATION ACT OF 1957

PUBLIC LAW 85-177; 71 STAT. 453

[H. R. 8992]

An Act to provide for the appointment of representatives of the United States in the organs of the International Atomic Energy Agency, and to make other provisions with respect to the participation of the United States in that Agency, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That:

This Act may be cited as the "International Atomic Energy Agency Participation Act of 1957".

Sec. 2. (a) The President, by and with the advice and consent of the Senate, shall appoint a representative and a deputy representative of the United States to the International Atomic Energy Agency (hereinafter referred to as the "Agency"), who shall hold office at the pleasure of the President. Such representative and deputy representative shall represent the United States on the Board of Governors of the Agency, may represent the United States at the General Conference, and may serve ex officio as United States representative on any organ of that Agency, and shall perform such other functions in connection with the participation of the United States in the Agency as the President may from time to time direct.

(b) The President, by and with the advice and consent of the Senate, may appoint or designate from time to time to attend a specified session or specified sessions of the General Conference of the Agency a representative of the United States and such number of alternates as he may determine consistent with the rules of procedure of the General Conference.

(c) The President may also appoint or designate from time to time such other persons as he may deem necessary to represent the United States in the organs of the Agency. The President may designate any officer of the United States Government, whose appointment is subject to confirmation by the Senate, to act, without additional compensation, for temporary periods as the representative of the United States on the Board of Governors or to the General Conference of the Agency in the absence or disability of the representative and deputy representative appointed under section 2(a) or in lieu of such representatives in connection with a specified subject matter.

(d) All persons appointed or designated in pursuance of authority contained in this section shall receive compensation at rates determined by the President upon the basis of duties to be performed but not in excess of rates authorized by sections 411 and 412 of the Foreign Service Act of 1946, as amended (22 U.S.C. 866, 867),[19] for Chiefs of Mission and Foreign Service officers occupying positions of equivalent importance, except that no Member of the Senate or

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[19] 22 U.S.C.A. §§ 866, 867.

House of Representatives or officer of the United States who is designated under subsection (b) or subsection (c) of this section as a delegate or representative of the United States or as an alternate to attend any specified session or specified sessions of the General Conference shall be entitled to receive such compensation. Any person who receives compensation pursuant to the provisions of this subsection may be granted allowances and benefits not to exceed those received by Chiefs of Mission and Foreign Service officers occupying positions of equivalent importance.

Sec. 3. The participation of the United States in the International Atomic Energy Agency shall be consistent with and in furtherance of the purposes of the Agency set forth in its Statute and the policy concerning the development, use, and control of atomic energy set forth in the Atomic Energy Act of 1954, as amended.[20] The President shall, from time to time as occasion may require, but not less than once each year, make reports to the Congress on the activities of the International Atomic Energy Agency and on the participation of the United States therein. In addition to any other requirements of law, the Department of State and the Atomic Energy Commission shall keep the Joint Committee on Atomic Energy, the House Committee on Foreign Affairs, and the Senate Committee on Foreign Relations, as appropriate, currently informed with respect to the activities of the Agency and the participation of the United States therein.

Sec. 4. The representatives provided for in section 2 hereof, when representing the United States in the organs of the Agency, shall, at all times, act in accordance with the instructions of the President, and such representatives shall, in accordance with such instructions, cast any and all votes under the Statute of the International Atomic Energy Agency.

Sec. 5. There is hereby authorized to be appropriated annually to the Department of State, out of any money in the Treasury not otherwise appropriated, such sums as may be necessary for the payment by the United States of its share of the expenses of the International Atomic Energy Agency as apportioned by the Agency in accordance with paragraph (D) of article XIV of the Statute of the Agency, and for all necessary salaries and expenses of the representatives provided for in section 2 hereof and of their appropriate staffs, including personal services without regard to the civil service laws and the Classification Act of 1949, as amended;[21] travel expenses without regard to the Standardized Government Travel Regulations, as amended, the Travel Expense Act of 1949, as amended,[22] and section 10 of the Act of March 3, 1933, as amended;[23] salaries as authorized by the Foreign Service Act of 1946, as amended,[24] or as authorized by the Atomic Energy Act of 1954, as amended,[25] and expenses and allowances of personnel and dependents as authorized by the Foreign Service Act of 1946, as amended; services as authorized by section 15 of the Act of August 2, 1946 (5 U.S.C.

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[20] 42 U.S.C.A. § 2011 et seq.

[21] 5 U.S.C.A. §§ 1071-1153.

[22] 5 U.S.C.A. §§ 835-842.

[23] 5 U.S.C.A. § 73b.

[24] 22 U.S.C.A. § 801 et seq.

[25] 42 U.S.C.A. § 2011 et seq.

55a);[26] translating and other services, by contract; hire of passenger motor vehicles and other local transportation; printing and binding without regard to section II of the Act of March 1, 1919 (44 U.S.C. 111);[27] official functions and courtesies; such sums as may be necessary to defray the expenses of United States participation in the Preparatory Commission for the Agency, established pursuant to annex I of the Statute of the Agency; and such other expenses as may be authorized by the Secretary of State.

Sec. 6. (a) Notwithstanding any other provision of law, Executive order or regulation, a Federal employee who, with the approval of the Federal agency or the head of the department by which he is employed, leaves his position to enter the employ of the Agency shall not be considered for the purposes of the Civil Service Retirement Act, as amended,[28] and the Federal Employees' Group Life Insurance Act of 1954, as amended,[29] as separated from his Federal position during such employment with the Agency but not to extend beyond the first three consecutive years of his entering the employ of the Agency: *Provided*, (1) That he shall pay to the Civil Service Commission within ninety days from the date he is separated without prejudice from the Agency all necessary deductions and agency contributions for coverage under the Civil Service Retirement Act for the period of his employment by the Agency, and (2) That all deductions and agency contributions necessary for continued coverage under the Federal Employees' Group Life Insurance Act of 1954, as amended, shall be made during the term of his employment with the International Atomic Energy Agency. If such employee, within three years from the date of his employment with the Agency, and within ninety days from the date he is separated without prejudice from the Agency, applies to be restored to his Federal position, he shall within thirty days of such application be restored to such position or to a position of like seniority, status and pay.

(b) Notwithstanding any other provision of law, Executive order or regulation, any Presidential appointee or elected officer who leaves his position to enter, or who within ninety days after the termination of his position enters, the employ of the Agency, shall be entitled to the coverage and benefits of the Civil Service Retirement Act, as amended, and the Federal Employees' Group Life Insurance Act of 1954, as amended, but not beyond the earlier of either the termination of his employment with the Agency or the expiration of three years from the date he entered employment with the Agency: *Provided*, (1) That he shall pay to the Civil Service Commission within ninety days from the date he is separated without prejudice from the Agency all necessary deductions and agency contributions for coverage under the Civil Service Retirement Act for the period of his employment by the Agency, and (2) That all deductions and agency contributions necessary for continued coverage under the Federal Employees' Group Life Insurance Act of 1954, as amended, shall be made during the term of his employment with the Agency.

(c) The President is authorized to prescribe such regulations as may be necessary to carry out the provisions of this section and to protect the retirement, insurance and such other civil service rights and privileges as the President may find appropriate.

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[26] 5 U.S.C.A. § 55a.

[27] 44 U.S.C.A. § 111.

[28] 5 U.S.C.A. § 691 et seq.

[29] 5 U.S.C.A. §§ 2091-2103.

Sec. 7. Section 54 of the Atomic Energy Act of 1954, as amended,[30] is amended by adding the following new sentences: "Unless hereafter otherwise authorized by law the Commission shall be compensated for special nuclear material so distributed at not less than the Commission's published charges applicable to the domestic distribution of such material, except that the Commission to assist and encourage research on peaceful uses or for medical therapy may so distribute without charge during any calendar year only a quantity of such material which at the time of transfer does not exceed in value $10,000 in the case of one nation or $50,000 in the case of any group of nations. The Commission may distribute to the International Atomic Energy Agency, or to any group of nations, only such amounts of special nuclear materials and for such periods of time as are authorized by Congress: *Provided, however*, That, notwithstanding this provision, the Commission is hereby authorized subject to the provisions of section 123, to distribute to the Agency five thousand kilograms of contained uranium-235, together with the amounts of special nuclear material which will match in amount the sum of all quantities of special nuclear materials made available by all other members of the Agency to July 1, 1960."

Sec. 8. In the event of an amendment to the Statute of the Agency being adopted in accordance with article XVIII–C of the Statute to which the Senate by formal vote shall refuse its advice and consent, upon notification by the Senate to the President of such refusal to advise and consent, all further authority under section 2, 3, 4 and 5 of this Act, as amended, shall terminate: *Provided, however*, That the Secretary of State, under such regulations as the President shall promulgate, shall have the necessary authority to complete the prompt and orderly settlement of obligations and commitments to the Agency already incurred and pay salaries, allowances, travel expenses, and other expenses required for a prompt and orderly termination of United States participation in the Agency: *And provided further*, That the representative and the deputy representative of the United States to the Agency, and such other officers or employees representing the United States in the Agency, under such regulations as the President shall promulgate, shall retain their authority under this Act for such time as may be necessary to complete the settlement of matters arising out of the United States participation in the Agency.

Approved August 28, 1957.

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[30] 42 U.S.C.A. § 2074.

REPORT OF THE ADVISORY COMMITTEE ON U.S. POLICY TOWARD THE INTERNATIONAL ATOMIC ENERGY AGENCY

MAY 19, 1962

Department of State
Washington, D.C.

INTERNATIONAL ATOMIC ENERGY AGENCY

May 19, 1962

The Honorable
Harlan Cleveland
Assistant Secretary of State for
International Organization Affairs,
Department of State,
Washington 25, D.C.

Dear Mr. Secretary:

Transmitted herewith is the report of the Advisory Committee which you appointed to review the policy of the United States toward the International Atomic Energy Agency.

Dr. Leland J. Haworth, Commissioner, United States Atomic Energy Commission, and Mr. Richard N. Gardner, Deputy Assistant Secretary of State for International Organization Affairs, participated in the formulation of the report and its conclusions as individuals; their views, of course, have not necessarily reflected the considered judgment of the Department of State and the United States Atomic Energy Commission to which agencies the recommendations are made. To avoid any misunderstanding of their roles, Dr. Haworth and Mr. Gardner have refrained from signing this report.

Henry D. Smyth
Henry D. Smyth, Chairman

Edward L. Brady
Edward L. Brady

Merrill Eisenbud

Norman Hilberry
Norman Hilberry

Philip Sporn
Philip Sporn

Edward R. Trapnell
Edward R. Trapnell

MEMBERS OF THE COMMITTEE

Henry D. Smyth	--United States Representative to the International Atomic Energy Agency. Chairman of the University Research Board, Princeton University. Formerly, Commissioner, Atomic Energy Commission; consultant, Manhattan District Project.
Edward L. Brady	--Assistant Chairman of Chemistry Department and Deputy Manager of Direct Conversion Project, General Atomic Division of General Dynamics Corporation. Formerly, Senior Scientific Adviser, United States Mission to the International Atomic Energy Agency; Scientific Representative in the United Kingdom, Atomic Energy Commission.
Merril Eisenbud	--Professor of Industrial Medicine, New York University. Director, Environmental Radiation Laboratory, New York University. Formerly, Manager, New York Operations Office, Atomic Energy Commission; Director, Health and Safety Laboratory, Atomic Energy Commission.
Richard N. Gardner	--Deputy Assistant Secretary of State for International Organization Affairs, Department of State. Formerly, Professor of Law, Columbia University; private practice of law, New York, N.Y.
Leland J. Haworth	--Commissioner, Atomic Energy Commission. Formerly, Director, Brookhaven National Laboratory; President, Associated Universities, Inc.; Professor, University of Illinois.
Norman Hilberry	--Senior Scientist, Argonne National Laboratory. Formerly, Director, Deputy Director, Argonne National Laboratory; Assistant Professor of Physics, New York University; Associate Project Director, Metallurgical Project, Manhattan Engineering District.
Philip Sporn	--Director and President, Ohio Valley Electric Corporation; Chairman of Research and Development Committee, East Central Nuclear Group. Until December 1961, President of American Electric Power Company and currently member of Executive Committee and Chairman, System Development Committee.
Edward R. Trapnell	--Special Assistant for Public Affairs to the Secretary of the Air Force. Formerly, Special Assistant to the Director General, International Atomic Energy Agency; Special Assistant to the General Manager, Atomic Energy Commission; Associate Director, Information Service, Atomic Energy Commission.

INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT OF THE ADVISORY COMMITTEE ON U.S. POLICY TOWARD THE I.A.E.A.

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INTERNATIONAL ATOMIC ENERGY AGENCY

Summary and Principal Recommendations

This Committee has reviewed the history of the International Atomic Energy Agency and of United States participation in Agency affairs, necessarily considering also the objectives and accomplishments of the United States Atoms for Peace Program. We have examined the present technical situation and probable future developments in the field of atomic energy and the role that the Agency might play in these developments.

We have concluded that the International Atomic Energy Agency in its first four years of life has served a useful function in promoting the development of the peaceful uses of atomic energy and has prepared itself for future activities of great significance.

Consideration of the United States Atoms for Peace Program has led us to conclude that the peaceful uses of atomic energy can and should play an important and fruitful role in our foreign policy. In our judgment, active support of the Agency is an effective means for furtherance of this policy.

We believe that various circumstances now combine to give the Agency considerable promise of future usefulness. This opinion is based on our judgment that the development of nuclear power is one key issue in determining the fate of the Agency and that nuclear power is on the threshold of economic attractiveness in a number of technologically advanced parts of the world. We believe that it is to the advantage of the United States to encourage and participate in this development.

We consider it to be of great importance that nuclear power be developed under conditions that discourage the diversion of nuclear materials to military uses. The Agency has already adopted a system of basic principles and procedures which constitute a good start toward the establishment of an adequate system of safeguards for materials and equipment procured under Agency auspices. Maintenance of an adequate world-wide safeguards system requires that transactions taking place under bilateral agreements contain provisions equivalent to those of the Agency or that the Agency be requested to administer its own system of safeguards for these transactions.

We have reviewed the activities of the Agency in technical assistance, dissemination of technical information, conduct of research, establishment of international standards and conventions, evaluation of economic aspects of nuclear power, and other fields. We have concluded that, in general, these activities have been competently carried forward and have contributed significantly to the basic goal of promoting the peaceful uses of atomic energy. Some detailed criticism will be found in the body of the report. On the whole, this Committee has been impressed by the technical competence of the staff of the Agency and by its morale, dedication, and enthusiasm during the difficult formative years just passed. In our judgment, many of the areas in which the Agency has been active are best carried forward by an international organization, and we believe that the Agency has shown its competence to be designated as the appropriate mechanism for these functions.

During its first four years, uncertainties about the course of development of nuclear power and about the strength and usefulness of the newly-formed Agency engendered a certain amount of caution in United States policy toward the organization. Clarification of the situation in the Agency as well as in nuclear power technology now provides a solid basis for clear-cut policy decisions.

This Committee recommends therefore that:

1. The United States reaffirm and constructively support its policy of furthering the utilization of atomic energy for peaceful purposes throughout the world.

2. The International Atomic Energy Agency be recognized as the most effective means by which the United States can carry out that policy. To that end, activities now being conducted under existing bilateral agreements should be transferred to Agency auspices wherever practical.

3. The United States take the lead in securing international agreement that the Agency be recognized as the instrument most appropriate for carrying out certain important functions in the field of atomic energy. In the opinion of the Committee, these include the following:

   a. The provision of the best attainable assurance against diversion of material and equipment to military purposes;

   b. The establishment of uniform health and safety standards;

   c. The provision of technical assistance;

   d. The reconciliation of liability and indemnification practices;

   e. The conduct of international research projects;

   f. The promulgation of waste management standards.

4. A detailed study be made within the United States Government of the steps to be taken to further foreign policy objectives in the field of atomic power. We believe that such a study will show that an effective program need not be costly.

5. The United States Government continue to support actively the programs of the Agency in the fields listed above by providing financial assistance, by supplying experts for special assignments, and by encouraging competent technical men to serve upon the Agency staff.

6. The United States Government take under advisement various other suggestions contained in the body of this report.

INTERNATIONAL ATOMIC ENERGY AGENCY

Introduction

The Task of the Committee

Since the enactment of the present Atomic Energy Law in 1954, the Atoms for Peace Program has been used by the Government of the United States to promote the development and world-wide application of the peaceful uses of atomic energy. Various international arrangments have been established to further this objective—agreements with other nations on a bilateral basis, agreements with regional groups of nations, and participation in the International Atomic Energy Agency (IAEA).

The Committee submitting this report was appointed by the Assistant Secretary of State for International Organization Affairs to examine U.S. policy toward the IAEA, to examine the role of that Agency in international atomic energy affairs and its usefulness in promoting the objectives of United States policy, and to make recommendations for future U.S. policy and activities.

The Technical and Political Importance of Atomic Energy

The discovery of the nuclear fission of uranium in the early months of 1939 was the culmination of a decade or more of work on nuclear disintegration carried out in many countries. This work had been pursued in the familiar tradition of science, with free interchange of ideas and information. It was realized that the amount of energy involved in these nuclear events was very large indeed but there was no reason to believe that a new controllable source of energy had been discovered. It had been shown that the vast amounts of energy generated in the stars must come from nuclear reactions but from reactions that took place under conditions totally different from anything on earth, or anything thought to be attainable.

The practical importance of the discovery of uranium fission lay in the particular nature of the process. It is caused by neutrons and produces neutrons. The key question, immediately apparent in 1939, was whether the number of neutrons produced could be made greater than the number used up. If so, a self-perpetuating chain reaction might be established which would release vast amounts of nuclear energy. If not, the fission of uranium was merely an intensely interesting type of nuclear event of little practical importance.

This key question was not answered before 1940 when the cloak of wartime secrecy descended on this field of investigation in all major countries. In August of 1945, proof that a chain reaction could be made to occur was first revealed publicly in the closing weeks of a long and bitter war by the dramatic explosion of an atomic bomb.

By the fall of 1945 it was universally recognized that a controlled nuclear chain reaction in uranium (first demonstrated in secret on December 2, 1942) makes available on earth a totally new source of energy, the kind of energy that keeps the sun glowing and the stars bright. This was the first new source of energy discovered in 100 years. Nuclear energy, like other forms of energy, can be used for peace or war. Moreover, in the course of its controlled release, radioisotopes are formed which have a great variety of uses in research, in medicine, and in industry.

Since that time the world has been awed by the power and mystery of this discovery, fearful of the destruction it can cause, hopeful of the benefits it can bring.

Throughout this period the United States has held a position of leadership. The first chain reaction was produced in this country, the first large nuclear reactor, the first weapon. Immediately after the war the United States advanced a generous and far-sighted plan for international control of nuclear energy hoping to insure its use for peace, not for war. The United States has continued to press for the control of nuclear weapons. At the same time the United States has led the world in the technology of peaceful uses of nuclear energy and has made its knowledge available to all nations.

The United States announced the Atoms for Peace Plan in 1953 in the General Assembly of the United Nations. This plan was consistent with our general belief that an improvement in the educational level and standard of living of the lesser developed countries contributes to the stability of the world. Atomic energy has provided a dramatic example of the way in which science and technology can contribute to a nation's welfare. Its exciting promises have called forth the serious interest and the support of most governments, including those of underdeveloped countries. Many programs for scientific and technical education are being stimulated by this interest. But to think of atomic energy as just another aspect of foreign aid is to ignore the facts of science and the realities of recent history.

The importance of atomic energy in our foreign policy rests on three basic facts: (1) The discovery of nuclear fission and fusion has had, and will continue to have, a greater influence on international affairs and on the way of life in the major industrial nations than any other single scientific discovery of the twentieth century; (2) Nuclear fission, and possibly fusion, together offer better long-range sources of energy than were dreamed possible a quarter of a century ago; (3) The leading position of the United States is more firmly established in this field than in any other field of applied physical science.

Taken in their totality these considerations led to the development of the U.S. Atoms for Peace Program, and are responsible for the enthusiasm with which the announcement of it was welcomed throughout the world. This enthusiasm was exemplified by the universal interest in the first and second Geneva Conferences on the Peaceful Uses of Atomic Energy in 1955 and 1958, surely the largest and most generally cooperative international technical conferences of our time. These considerations also led to the establishment of the International Atomic Energy Agency with headquarters in Vienna. By cooperating in this venture, the nations of the world gave recognition to the industrial, political and psychological importance of atomic energy and expressed their determination to use it for peaceful purposes.

CHAPTER 1

The Committee's Assessment of Present Conditions and Prospects

Prospects for Nuclear Power and Related International Problems

Although the development of practical, economic nuclear power plants has been found to be a more difficult and more time-consuming task than was first thought, current appraisals indicate that nuclear power will be commercially attractive in a number of countries in the near future. (The basis for this conclusion is discussed in Chapter II.) The members of the Committee believe that cooperation of the United States with these countries will promote their economic development.

Since we are convinced that international commerce in the atomic industry will increase significantly during the next decade, we believe that it is necessary for the United States to work together now with the other nations of the world to reach agreement on some of the terms and conditions of this trade. A problem of major importance is the control of nuclear materials intended for peaceful uses. Such a system of "safeguards" to prevent diversion to military use is not easy to establish. Many other questions arise: health and safety standards, third party liability in case of nuclear accidents, regulations for transport of radioactive materials across international borders, management of nuclear waste to prevent contamination across national boundaries, etc. We believe answers to these questions to be essential for the orderly development of international trade.

Value of the Atoms for Peace Program

We further believe that the United States has gained and can continue to gain benefit from the Atoms for Peace program. All the world knows that our nuclear military might is great. Knowledge of our development of the peaceful uses of atomic energy, being less dramatic, does not receive the same degree of world attention. We are convinced that it is to the advantage of the United States that the people of the world have an appreciation of the enormous contribution in effort and money made by our government to the peaceful uses of atomic energy. We believe that the Atoms for Peace program has, in the past, helped to foster such appreciation in the many parts of the world.

For these reasons, the members of this Committee share the view that the Atoms for Peace program has contributed significantly to the promotion of U.S. political objectives. This has been accomplished in a rather short period of time and with remarkable economy of means. In our opinion, nuclear power is on the verge of becoming of practical importance in various parts of the world, and expansion of at least some aspects of the Atoms for Peace program (whether under this name or another) over the next few years is inevitable.

Once the Committee had agreed on its general assessment of the prospects for nuclear power and the usefulness of an Atoms for Peace program, we examined the past and possible future role of the International Atomic Energy Agency. We then examined the advantages of the Agency compared to bilateral or multilateral arrangements and the place of the Agency in the United Nations family of organizations.

The Performance and Cost of the IAEA

In accordance with its general desire to promote the peaceful uses of atomic energy the United States has given vigorous support to the International Atomic Energy Agency. After reviewing the nature of technical and political problems of atomic energy that have an international character and the approaches already taken by the Agency to solve these problems, it is our considered opinion that in its four years of existence, the Agency has performed valuable and unique services for the nations of the world and can in the future continue to increase its value and its scope. The Committee hopes that this report provides some useful guidance as to the Agency's present and potential contributions to the world-wide development of applications of nuclear energy.

Almost every means of promoting our foreign policy requires the expenditure of funds. It is very difficult to compare the effectiveness of dollars spent in different programs. By way of guidance in the present discussion, it should be noted that the annual contribution of the United States to the IAEA runs somewhere between $2 and $3 million. For comparison, the operating cost of one of our national Atomic Energy laboratories, Oak Ridge, was $67.6 million in 1961, our contributions to various international organizations including the United Nations about $150 million, and our total foreign aid about $4 billion.

The IAEA vs. Bilateral and Regional Agreements

Because of the difficulties inherent in setting up an international organization, four years elapsed between President Eisenhower's speech to the United Nations in 1953 introducing the concept of an international atomic energy organization and the formal establishment of that organization.

During this four-year period, the United States entered into a number of bilateral agreements with various countries calling for cooperation in the development of the peaceful uses of atomic energy. Also during that period, or immediately thereafter, a number of regional organizations were formed. The United States has now entered into cooperative arrangements with the European Atomic Energy Community (Euratom), the European Nuclear Energy Agency (ENEA) of the OECD, and the Inter-American Nuclear Energy Commission (IANEC) of the Organization of American States.

While the achievements of Euratom have fallen short of its initial target and the Joint U.S.-Euratom power reactor porgram has not matched the original plans, the Euratom organization has established itself as a vigorous and competent group capable of carrying forward an appropriate atomic energy program in its member countries. The ENEA and IANEC organizations were formed with different terms of reference than Euratom and have also proved to be useful in their more limited spheres of activity.

The bilateral agreements have been more important in laying the groundwork for future developments than in actual achievement. It has frequently been urged that the bilateral agreements be superseded by arrangements through the IAEA.

INTERNATIONAL ATOMIC ENERGY AGENCY

The Committee feels strongly that the relative roles of the International Agency, arrangements with regional organizations and bilateral agreements must be judged in the whole context of our foreign relations. In making this judgment it must be recognized there are certain disadvantages in dealing through an international organization. Such an organization is often cumbersome and slow. On the other hand, there are functions which are best carried out through an international organization such as the IAEA. In the opinion of the Committee, these include the following: (1) provision of best attainable assurance against diversion of materials and equipment, (2) the establishment of uniform health and safety standards, (3) the promulgation of waste management standards, (4) the reconciliation of liability and indemnification practices, (5) the conduct of international research projects, (6) the provision of assistance to those nations which for political reasons do not wish to become closely associated bilaterally with the nuclear policy of one of the major nuclear powers and (7) other functions which necessarily involve cooperative action of many nations.

The fact that the Agency is uniquely designed to perform such tasks more effectively than other organizations requires a clear-cut definition of its responsibilities in these areas. There must be a positive assignment of these functions, and the capability to discharge them effectively must be built on a program of actual participation in a wide range of activities related to atomic energy. Further, such participation must be sufficiently broad to develop a well-rounded staff able and eager to undertake a variety of tasks, including those for which the Agency is uniquely suitable.

One method of encouraging the development of Agency competence is to transfer to it as many as possible of the activities that are now being carried out bilaterally, if they fit properly and usefully into the Agency's program. This requires agreement between both bilateral partners. It is our understanding that it is the policy of the United States to propose to bilateral partners that transfers of materials and equipment and the pertinent safeguards now carried out under bilateral agreements henceforth be transacted through the Agency, thereby obviating the necessity for extension of such agreements. This Committee endorses this policy and recommends its continuation. The Committee hopes that other nations can be persuaded to adopt a similar policy.

It is perhaps desirable to point out that this policy is consistent with the wishes of many nations of the world, which prefer to use Agency mechanisms for assistance rather than bilateral transactions with one of the major nuclear powers, which may carry both the flavor of paternalism and the hint of dependence. Many of the newly developing nations of the world are participants in the Agency. They are proud of their membership, and wish to negotiate through the Agency as equal partners with the major nations of the world. It is important that the Agency foster this attitude and make its operations so efficient ad so effective that an increasing number of nations will wish to use its services. It is possible that the U.S. can assist in making the use of the Agency more attractive.

The IAEA in the United Nations Family of Organizations

The IAEA is only one of the members of the UN family of organizations. All of the organizations in the UN system are related to the UN itself and to each other by special agreements which set forth in broad terms the guidelines for cooperation and coordination of activities. Before the IAEA had developed its program there was constant worry that the other agencies would overlap or unsurp activities in the field of peaceful uses of atomic energy which legitimately belonged to the IAEA. In most instances this has proved not to be true. As the IAEA has developed and its program and activities have been established, a successful working relationship has been developed among these organizations. Cooperative and joint ventures have become the rule rather than the exception.

The Committee recognizes that the other members of the UN family have an interest in the uses of atomic energy as they are applied to their various fields of endeavor: agriculture, medicine, industry, education, etc. However, the Committee also believes that the IAEA should be the primary organization charged with promoting the peaceful uses of atomic energy in all fields. Although this has been acknowledged U.S. policy, it is believed that the policy could be more vigorously pursued, particularly when the question arises within the other agencies. The Committee recognizes that it would be impracticable to attempt to delineate specific responsibilities or activities, but it considers that work in the atomic energy field should be concentrated under the IAEA except where it is clearly demonstrated that the "atomic" aspect of the activity is subsidiary to some other aspect. Even in these cases, however, the IAEA should play an important advisory role.

Major Factors in tne Future of the IAEA

We have presented the Committee's general assessment of the desirability of continuing support of the IAEA. The implication of our discussion is that such support should continue but we wish to make clear the major factors considered in reaching such a conclusion. It is not sufficient, in our opinion, to argue that the Agency exists and therefore, we should do what we can to nurture it. The Agency's justification of existence must be that it is able to carry out some of the tasks involved in promoting the world-wide peaceful use of atomic energy more effectively than other possible mechanisms.

In discussing the future of the IAEA we believe that the paramount consideration is the future of nuclear power. All the other peaceful uses of nuclear energy, and there are many, are relatively modest in their demands for money and effort. Furthermore, they are closely associated with other fields such as agriculture, medicine, and the like.

If nuclear power comes into general use, the possibility of illicit manufacture of nuclear weapons will be greatly increased and "safeguards" against the diversion of materials and equipment to military uses will become of major importance.

The future of nuclear power and of "safeguards" are principal factors affecting the contributions that the Agency can make in the future. But the areas in which the Agency has already been active will continue to be important. These include regulatory activities, technical assistance, East-West cooperation and other work designed to promote the peaceful uses of atomic energy throughout the world. The continuing impact of these activities is the third major factor relevant to the future of the Agency and may by itself justify continued vigorous support of the Agency.

In the remainder of this report we will attempt to analyze the future of nuclear power, the problem of safeguards and the importance of the other multifarious activities of the Agency. Our conclusions and recommendations are based on this analysis.

CHAPTER 11

Analysis in Support of Committee Assessment

The Cost of Nuclear Power

During the last fifteen years the published material on the cost of nuclear power has reached vast proportions. There have been government reports, studies by utility groups, studies by private foundations and by international groups including the IAEA. In quality these reports have ranged from fact to fantasy, but as experience has accumulated there has been a marked increase in the reliability of the conclusions and predictions made. Particularly in the last year or two, solid information based on experience has accumulated at an increasing rate and has made it possible to estimate costs with an accuracy approaching that accepted in more conventional engineering estimates.

Several members of our Committee have had many years of experience with cost estimates of nuclear power and have learned to view them with skepticism. To bring our knowledge up to date we listened to the testimony of experts from the AEC, to comments of several members of the Committee, and to other witnesses of competence.* After discussing this testimony the members of the Committee agreed to the assessment presented below.

One of the basic asumptions which led to the establishment of the IAEA was that nuclear power would be of great economic importance in the immediate future. Though this assumption in the period 1954-1957 was premature, considerable progress in the development of the technology and in improving the competitive economics of nuclear power has been made in the intervening six year interval. We have reached a stage where nuclear reactors, in large sized units, can be undertaken for completion, roughly in the period 1966-67, which will be competitive in high cost fuel areas--say areas having fossil fuel costs of approximately 40¢ per million Btu. Thus, if the first basic assumption underlying the setting up of IAEA has not as yet become valid, it is, perhaps, close to becoming so.

Furthermore, there are number of technologically-advanced and economically highly-developed nations with high energy demands which can be and will soon begin to use significant amounts of nuclear energy to meet their growing energy requirements. These nations will, at least in the beginning phases of the development of their nuclear energy programs, need help. Broadly speaking, the same is true of the lesser developed nations.

Among the lesser developed countries there are a number now in the process of industrialization which would be well advised to start planning and building at least their first nuclear plants.

There are other smaller nations needing assistance to start their development. Even if nuclear power can as yet not help them, nuclear science is uniquely able to stimulate development of education and to encourage taking the first steps in applying science and technology to improve standards of living. The latter is a particularly desirable goal to attain among many of the smaller, newly emerging nations which it is in our interest to help.

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*The most recent general review of the nuclear power situation is the report of the "202" hearings before the Joint Committee on Atomic Energy of the U.S. Congress beginning March 20, 1962.

All this, it is clear, while not envisioning a program of a vast number of nuclear power plants sprouting up overnight around the world, still comes within the special abilities of IAEA to aid and encourage.

In looking beyond the next five years the Committee recognizes that conventional power costs may drop because of technical advances and a plentiful supply of oil. Nevertheless there is at least a good prospect that nuclear power costs may drop more rapidly.

The question of the costs of power from small nuclear plants is more difficult. It is conceded that the cost per kwhr rises as the total output of the plant decreases. It is further conceded that this differential in favor of large plants is greater for nuclear plants than for conventional plants. Nevertheless, a recent AEC publication gives cost estimates for power from small nuclear reactors that are lower than had been generally assumed. It seems likely that there are remote areas of the world where the cost of conventional fuel is so high that 15-20 mils/kwhr power from a 20,000 kw nuclear plant may look economically attractive. We believe a continuing exploration of such possibilities would be a highly appropriate undertaking for the IAEA.

It is against the background of the economic and technical situation we have just presented, coupled with the more general considerations discussed in the earlier sections of this report, that the Committee has concluded that it is to the advantage of the United States to encourage and support the development of nuclear power in various parts of the world. From this point of view it is clearly to the advantage of the United States to support the IAEA with increasing vigor.

Methods of Supporting the Utilization of Nuclear Power

Granted the general desirability and timeliness of the U.S. supporting the development of nuclear power throughout the world, it is necessary to examine methods and costs.

Although the nature of technical and financial assistance which is most appropriate will vary from country to country, the Committee was able to come to certain general conclusions.

Specifically, the Committee concluded that it would not be wise to promote the construction of "experimental" nuclear power reactors in under-developed countries. We believe that the notion of simultaneously stimulating the use of nuclear power in other countries and advancing the technology is illusory. Any reactors that we encourage outside the U.S. should be of well-tested types.

There are several ways in which we can promote the construction of nuclear power reactors outside the United States. One way is to furnish technical advice. A second is to help carry out the special work that is necessary before even a well-tested type of reactor can be adapted to a particular use and location. A third way is to provide or help provide for the architect-engineer services. A fourth way would be to offer fuel at less than commercial prices. A fifth possibility is a capital subsidy in the form of U.S. dollars, material or equipment. Which of these methods may be preferable will depend on political, economic and technological circumstances.

It is the conviction of our Committee that, in most cases, help under the aegis of the IAEA is preferable to purely bilateral help. We have already given general reasons for using the Agency. There are two other arguments in favor of the Agency: (1) We believe that operations through the Agency will help to obtain an objective, international evaluation of the merits of specific proposals, thereby relieving the U.S. of some of the burdens of carrying out the selection alone. (2) We believe that use of the Agency will maximize the probability of obtaining a consistent inclusive safeguards system, while minimizing the burdens that would be borne by the United States through administration of a bilateral system of safeguards.

In this connection the past activities of the Agency are relevant. One of the useful functions that the Agency staff has carried out has been to examine critically the assumption that nuclear power was a panacea of immediate value to all countries. In this action an objective, internationally recruited staff succeeded in putting nuclear power for under-developed countries in a realistic perspective. Such sober, conservative appraisal by the Agency Secretariat is one of the factors that has led the members of this Committee to have a high regard for the technical judgment and competence of the Secretariat.

This Committee is not able at this time to make a general recommendation regarding the methods of support to be preferred, and we suggest that the staff of the Atomic Energy Commission examine the possibilities listed above in order to determine the potential advantages and disadvantages of each method of assistance. Since political and economic, as well as technological, factors will be important, studies should be made in cooperation with the Department of State and in consultation with the appropriate Congressional committees.

Safeguards

One of the objectives in the minds of many of the founders of the International Atomic Energy Agency was to encourage the expansion of the peaceful uses of atomic energy without expanding the number of countries producing atomic weapons. For this purpose the Agency was to set up a system of control and inspection of nuclear facilities obtained under Agency auspices, and was also to encourage the nations of the world to place their own facilities voluntarily under the Agency system. The technical objective of this system would be to provide a means of detecting the diversion of nuclear materials and facilities within a reasonable length of time after the diversion had occurred.

In addition, the United States and some other Western nations envisioned placing safeguards arrangements called for in bilateral agreements under Agency administration, and we hoped to reach agreement with all Western supplier nations that bilateral transactions be subject to a safeguards system equivalent to that of the Agency, if not actually administered by the Agency.

The hopes for the success of such a system of control were based on the assumption that: (a) the demand for nuclear fuels for power would become widespread, and (b) the supply of uranium fuel for power reactors would continue to be extremely limited and therefore relatively easily controlled.

These assumptions proved to be incorrect. Reduction in the cost of nuclear power came much more slowly than was anticipated while at the same time large reserves of uranium were discovered in the U.S. and Canada, and deposits of significant size were found in many other parts of the world.

During the first years of Agency life, the safeguards question was a bitterly contested issue in the Board of Governors. After nearly three years of debate in the Board and in the General Conference, a limited but adequate system of controls and inspections was worked out for nuclear facilities procured or substantially assisted under Agency auspices. The United States exerted strong influence to secure Board of Governors approval of this system. Though the actual control of material and the reports required by the system are little more than prudent management would prescribe, the inspection system appears to be difficult for many countries to accept for political reasons.

The members of this Committee subscribe wholeheartedly to the general principle that it is desirable to ensure that none of the materials made available for peaceful purposes through the Agency or by other means should be diverted to military uses. While recognizing the technical, operational and political obstacles to effective administration of Agency safeguards and appreciating the difficulties of securing uniform bilateral adherence, the Committee believes that the United States should continue to take the lead in establishing a uniform world-wide, effective system of safeguards.

It appears to the Committee that heavy pressures are now being exerted against the Agency safeguards system and that these pressures will probably increase in the future. The world production capacity for uranium is now in excess of foreseeable needs for both military and commercial uses. There is apparently a feeling (unjustified, in our opinion) among some producers that safeguards constitute a hindrance to sales. The desire to sell is strong, and growing stronger, and there is a real possibility that a number of governments of producer countries would not be willing to insist upon safeguards if a customer should refuse to buy on this condition. Such arrangements if made with increasing frequency could lead in a few years to a breakdown of the safeguards system.

Any safeguards system must take into account the special problems that would be created by the widespread distribution of highly enriched U-235 as reactor fuel. The policy of the U.S. Government in this respect must be continually examined in the light of U.S. interest in safeguards.

We have been assured by responsible officials of the Department of State and of the Atomic Energy Commission that safeguards problems are under almost continuous review and that various possibilities are being explored in efforts to maintain effective world-wide safeguards. Because of the importance of this matter, the committee urges these officials to pursue vigorously all possibilities and to maintain unflagging devotion to the basic principle of securing world-wide adherence to an effective system of safeguards.

There is a nightmarish dilemma about all attempts to control atomic weapons. The political acceptability of any system proposed seems to be inversely proportional to its effectiveness. Unquestionably the most effective system ever proposed was the Baruch Plan of 1946. This plan envisaged complete international ownership and control of all steps in the process of going from raw materials to fuel for reactors or weapons material and included ownership of power reactors and reprocessing plants, responsibility for development of nuclear power, and so on. A technically more limited scheme may still be a useful step forward and yet more acceptable.

Whatever technical arrangements are made for the control of atomic weapons will depend for their success as much on the economic and political circumstances relevant to them as on the technical details of the system. The complete spectrum of actions to be considered ranges from the purely political to the purely technical. Political recommendations are outside the jurisdiction of this Committee, but we do wish to emphasize that the safeguards system set up by the Agency, though technically sound and worthy of vigorous support by the U.S., is only one step along the difficult path leading to control of atomic weapons.

Conclusions on Nuclear Power and Safeguards

As stated at the end of Chapter I the Committee considers the future of nuclear power of basic importance to the future of the IAEA. The question of "safeguards" is closely related. If we do not have nuclear power, safeguards are not of major importance. Up to the present time activity of the IAEA in the field of nuclear power and safeguards has been, necessarily, preparatory. The nature of IAEA activities will be profoundly affected if the Committee's conclusions are correct. For this reason we summarize them here before discussing the other activities of the IAEA and their future importance.

On the basis of the arguments presented in the two previous sections of this report, the Committee has concluded that:

1. Nuclear power plants will be built in significant numbers around the world during the next decade;
2. Vigorous participation in this development is to the advantage of the United States;
3. In most cases such participation is best carried out through the IAEA;
4. Without effective, world-wide controls, either political or technical or both, nuclear products of nuclear power plants can be readily diverted to the manufacture of atomic weapons;
5. The answer to the safeguards problem lies in a vigorous and technically competent international organization.

Current Activities of the IAEA

The first part of this chapter has been devoted principally to a discussion of nuclear power and of safeguards. These were orginally envisaged as important activities of the IAEA but have in fact been largely preparatory because of the technical difficulty of developing competetive nuclear power. However, other activities arising from the Statute and elaborated in the Report of the Preparatory Commission have been carried out effectively by the Agency. In general, our Committee believes the Agency has done remarkably well in carrying out these tasks. The Committee has reviewed these activities in some detail and will comment on them in this part of its report.

Standards and Codes. Perhaps the most obviously appropriate activities of the International Agency have to do with health and safety problems arising out of the use of atomic energy in various forms. The questions involved in setting up appropriate codes and standards are both legal and technical. The Agency has made real strides forward in several areas. For the safe transport of radioactive materials it has drawn up a code in a form which can be either adopted or used as guidance for national or international codes. Similarly, a great deal of work has been done on such matters as liability for nuclear accidents, and health and safety standards. The Agency has not only taken commendable initiative in setting up such codes and in establishing international acceptance of them, but in several cases has engaged or is engaged in relevant research. The Agency laboratory at Siebersdorf is also active in standardizing sources of various radioactive isotopes, a highly appropriate activity for this laboratory.

In the opinion of the Committee, the U.S. should continue to support and encourage the IAEA in these activities which are so clearly beneficial to all countries engaged in atomic energy work and which futhermore can be more effectively pursued under an international rather than under a national aegis.

Health and Safety. The Committee regards activities in the establishment and dissemination of health and safety standards to be a highly appropriate undertaking for the Agency. The establishment of a reasonably uniform world pattern of health and safety standards is inherently a worthwhile objective in furthering the uses of nuclear power. As an example of Agency activities in this field, we may cite an elaborate detailed document on health standards recently submitted to the Board for approval. Prepared by the Secretariat after much discussion with a panel of experts, the document was accepted by the Board as a working paper to be made available to interested parties but to be further examined as to some technical details.

Waste Management. In the field of radioactive waste management, the Committee supports the concept of an international convention on sea disposals. It also considers that the educational and technical objectives of the Agency's program could be substantially advanced by focusing attention on some short range problems of an engineering type rather than by attempting to consider all problems in a general way. As examples of actual situations that might be studied, the Committee suggests measurement of the level of radioactivity of one of the international rivers of Europe, or the selection of a site for sea disposal.

Liability. It should also be pointed out that the Agency has aided greatly in the continuing proceedings looking toward the adoption of international conventions on legal liability for nuclear incidents, both on land and at sea. The latest move in this direction was taken by the Board of Governors in its March 1962 meeting in which the Board authorized the Director General to issue an invitation to the Member States to participate in a diplomatic conference to consider a draft convention on civil liability for nuclear damage from land-based installations.

Technical Assistance. There is an apparent tendency on the part of many, if not most, of the Member States of the Agency to consider technical assistance to the lesser developed states as the primary reason for the existence of the IAEA. The members of this Committee do not subscribe to this view; on the contrary, they hold the opinion that if technical assistance alone were the justification for the existence of the Agency, perhaps these activities should be turned over to other organizations and the Agency discontinued.

We do not wish to give the impression that we consider technical assistance unimportant; indeed, up to the present time it is perhaps the most important and most successful activity of the Agency. This importance derives from the fact that many far-sighted responsible authorities in lesser developed countries have seized upon atomic energy as the base upon which to build the technical development of their countries. Atomic energy programs are pointing up the need for technical education in all fields and provide an unparalleled opportunity for the advanced nations to aid the newly developing countries to promote their scientific and engineering education programs.

The Committee believes it to be in the interest of the United States that technical assistance in atomic energy continue to be available to developing countries through the IAEA. Such assistance should, of course, be at a level both in amount and in sophistication suited to the individual needs and capabilities of the recipient countries. In order to ensure that the recipient countries are making best possible use of the assistance provided and in order to assist in coordinating Agency activities with those of other organizations, the Secretariat should maintain close contact with the atomic energy programs of all member states, especially those of the recipient nations. This contact should consist of reports from responsible authorities, of follow-up missions along the lines of the preliminary assistance missions, or of the assignments of experts who would keep the Agency informed of progress.

The technical assistance program of the Agency has consisted of the provision of fellowships for advanced training, of exchange professorships for research, of special experts for various purposes, of equipment and grants to implement research and training programs, and of assistance in the organization of special courses. All these types of activities have been successfully carried on by the Secretariat and are worthy not only of support by the United States but of encouragement to expand.

(a) Fellowships. The fellowship program deserves special mention. Over one thousand fellowships have been granted, and the representatives of many member states have frequently pointed out the great importance they attach to this activity and their high regard for the way the program has been administered. The Committee is of the opinion that the grant of U.S. financed fellowships to the Agency (so-called Type II fellowships) should be continued, and possibly expanded. It is recognized that in some countries there may be difficulties in finding useful employment in "atomic energy" research and development for returning fellows and that the Agency, therefore, must exercise judicious selection procedures. In offering fellowships, the United States should take into consideration the fact that broad training of a fellow may sometimes be of greater value in promoting the application of atomic energy in his home state than mere specialized training. For example, a year of general study in advanced physical chemistry may prove to be of greater value than a year of specialized study of the chemical technology of reactor materials.

(b) Visiting Experts. One of the forms of technical assistance in which the United States has been particularly active is the provision of special experts to serve as consultants to the Agency and to individual member states. Indeed, some of the members of his Committee have gained experience with the activities of the

Agency through serving in this capacity. The Committee holds the opinion that this form of technical assistance is a particularly effective means of aiding and influencing the newly developing atomic energy and technical education programs of the recipient states. For this reason we recommend that the U.S. practice of providing cost-free experts to member states through the Agency be not only continued but expanded.

(c) Equipment Grants. The Committee noted that the amount of money available for the Agency's program of equipment grants has been relatively small. However, various members of the Committee have learned from personal contact with a number of the recipients that the equipment has been of crucial importance, and it is believed that this is generally true. The struggles of some very competent scientists in the newly developing countries to obtain money for even a few of the most basic items of research are well known to members of this Committee. In view of this, it is the Committee's opinion that the equipment grant program could justifiably be expanded. At the same time, the Committee noted that there may well be circumstances in which the bilateral approach may prove a faster and more effective means of furnishing equipment.

(d) Appropriate Fields. In addition to its consideration of the mechanisms of technical assistance, the Committee also discussed the subject matter with which the assistance should be concerned. In the opinion of the Committee, the most important subject for technical assistance is the improvement of the means of providing advanced scientific and technological education in the recipient countries. Achievement of this goal will have far-reaching consequences throughout the society of the country assisted. Therefore, the provision of experts, grants of equipment, and awards of fellowships should in the majority of instances be concentrated around the educational needs of the recipient countries.

(e) Use of Isotopes. In addition, it is the opinion of this Committee that most attention in the newly developing countries should be focused on the manifold uses of isotopes. "Atomic Energy" in most of these countries has found its first practical use in the form of an application of radioisotopes to medical or agricultural problems. Medicine and agriculture are fields in which all countries have both needs and competence. Numerous applications of isotopes in medicine and agriculture have already appeared; in many cases equipment is relatively simple and cheap. This Committee recommends, therefore, that the United States continue its policy of encouraging the Agency in the promotion of applications of isotopes in agriculture and medicine and that even greater emphasis be placed in the future on these matters. (This is not to say that nuclear power needs should be neglected, but is a reflection of our appraisal that in the majority of the newly developing countries nuclear power is not of immediate urgency.)

(f) Research Aid. One means of providing technical assistance that will undoubtedly prove to be of steadily increasing importance is the placement of contracts for research in laboratories of the lesser developed countries. The Committee regards the past practice of the Agency as commendable but believes that in the future greater care should be taken to place research contracts where most can be accomplished, taking into consideration both the needs of the laboratory and the scientific merit of the proposed research. Projects that would seem particularly appropriate for this activity are those which require international planning and coordination, such as for example, the transport of radioactive material by international rivers, studies of natural radioactivity distributions throughout the world, studies of the use of radioactive materials to reduce or eliminate damage from internationally distributed insect pests, etc.

IAEA Research. The Committee recognizes that funds available to the Agency for its own research are, and will probably continue to be, of limited magnitude and that there is therefore some question of the desirability of the Agency's continuing a research function at all, since its share of the total funds devoted to nuclear research and development is small. The members of the Committee do not support this view; on the contrary, we believe that the research activities authorized by the Statute and by the actions of the Board of Governors are an important function of the Agency and that consideration should be given to enlargement of their scope. Limited as the research funds may be, they are adequate for the carrying out of very significant research programs if the selection of problems and laboratories is carefully made. In making the selection, the Agency should not, in the opinion of the Committee, place research contracts in the more advanced countries unless there are special reasons for doing so. In all cases, before granting a contract to a research institution in an advanced country, the Agency should determine whether the government or private sources in the country or elsewhere would be prepared to undertake the project at their own expense. In this way research of direct value to the Agency and research supported as part of the technical assistance program can supplement each other.

In its discussions, the Committee examined briefly the program initiated by, Mr. John A. McCone (then Chairman of the USAEC) of support of the Agency's research program through the financing of Agency and AEC-approved proposals which have programmatic interest to the United States. It is the Committee's opinion that U.S. funds can be advantageously used, both to obtain good results and to provide support to establishments that might otherwise be unable to conduct useful research. The Committee therefore favors the continuation and expansion of the present program of supporting through the IAEA projects which are of interest to the U.S.

Study Program. As has already been mentioned, the Agency has made several studies of nuclear power costs. Specifically, studies have been made of the possible economic advantage of nuclear power in particular countries. The Committee believes that such activities have been useful and should be continued vigorously.

Information Program. The Committee is of the opinion that the Agency's program of scientific meetings has been extremely good as topical conferences and that these conferences are being increasingly well run. The Committee discussed the question of a Third International Conference on the Peaceful Uses of Atomic Energy and agreed that if such a conference is to be held it should be sponsored by the IAEA. The Conference, in the Committee's view, should be reduced in size, scope and length over the previous two conferences, but should still be sufficiently attractive to warrant attendance by participants not only of high scientific and technical standing but also of top economic and political responsibility in the nation they represent.

On the whole, the Committee believes that the Agency's publication program has been good. The proceedings of technical meetings and the Journal of Plasma Physics and Thermonuclear Fusion have maintained high technical standards. On the other hand, the Review Series has not maintained consistency in the technical level of its content nor in its direction toward a specific audience level. In addition, it has not been well distributed. The Committee believes that, in place of this publication, the Agency might consider commissioning articles for publication in reputable scientific journals with the Agency distributing reprints of the articles.

EXCERPTS

Treaty for the Prohibition of Nuclear Weapons in Latin America

Signed at Mexico City February 14, 1967
Entered into force April 22, 1968

Obligations

Article I

1. The Contracting Parties hereby undertake to use exclusively for peaceful purposes the nuclear material and facilities which are under their jurisdiction, and to prohibit and prevent in their respective territories:

(a) The testing, use, manufacture, production or acquisition by any means whatsoever of any nuclear weapons, by the Parties themselves, directly or indirectly, on behalf of anyone else or in any other way, and

(b) The receipt, storage, installation, deployment and any form of possession of any nuclear weapons, directly or indirectly, by the Parties themselves, by anyone on their behalf or in any other way.

2. The Contracting Parties also undertake to refrain from engaging in, encouraging or authorizing, directly or indirectly, or in any way participating in the testing, use, manufacture, production, possession or control of any nuclear weapon.

* * *

Definition of nuclear weapons

Article 5

For the purposes of this Treaty, a nuclear weapon is any device which is capable of releasing nuclear energy in an uncontrolled manner and which has a group of characteristics that are appropriate for use for warlike purposes. An instrument that may be used for the transport or propulsion of the device is not included in this definition if it is separable from the device and not an indivisible part thereof.

Meeting of signatories

Article 6

At the request of any of the signatory States or if the Agency established by article 7 should so decide, a meeting of all the signatories may be convoked to consider in common questions which may affect the very essence of this instrument, including possible amendments to it. In either case, the meeting will be convoked by the General Secretary.

Organization

Article 7

1. In order to ensure compliance with the obligations of this Treaty, the Contracting Parties hereby establish an international organization to be known as the "Agency for the Prohibition of Nuclear Weapons in Latin America," hereinafter referred to as "the Agency." Only the Contracting Parties shall be affected by its decisions.

2. The Agency shall be responsible for the holding of periodic or extraordinary consultations among Member States on matters relating to the purposes, measures and procedures set forth in this Treaty and to the supervision of compliance with the obligations arising therefrom.

3. The Contracting Parties agree to extend to the Agency full and prompt co-operation in accordance with the provisions of this Treaty, of any agreements they may conclude with the Agency and of any agreements the Agency may conclude with any other international organization or body.

4. The headquarters of the Agency shall be in Mexico City.

Organs

Article 8

1. There are hereby established as principal organs of the Agency a General Conference, a Council and a Secretariat.

2. Such subsidiary organs as are considered necessary by the General Conference may be established within the purview of this Treaty.

The General Conference

Article 9

1. The General Conference, the supreme organ of the Agency, shall be composed of all the Contracting Parties; it shall hold regular sessions every two years, and may also hold special sessions whenever this Treaty so provides or, in the opinion of the Council, the circumstances so require.

2. The General Conference:

(a) May consider and decide on any matters or questions covered by this Treaty, within the limits thereof, including those referring to powers and functions of any organ provided for in this Treaty.

(b) Shall establish procedures for the control system to ensure observance of this Treaty in accordance with its provisions.

(c) Shall elect the Members of the Council and the General Secretary.

(d) May remove the General Secretary from office if the proper functioning of the Agency so requires.

(e) Shall receive and consider the biennial and special reports submitted by the Council and the General Secretary.

(f) Shall initiate and consider studies designed to facilitate the optimum fulfilment of the aims of this Treaty, without prejudice to the power of the General Secretary independently to carry out similar studies for submission to and consideration by the Conference.

(g) Shall be the organ competent to authorize the conclusion of agreements with Governments and other international organizations and bodies.

3. The General Conference shall adopt the Agency's budget and fix the scale of financial contributions to be paid by Member States, taking into account the systems and criteria used for the same purpose by the United Nations.

4. The General Conference shall elect its officers for each session and may establish such subsidiary organs as it deems necessary for the performance of its functions.

5. Each Member of the Agency shall have one vote. The decisions of the General Conference shall be taken by a two-thirds majority of the Members present and voting in the case of matters relating to the control system and measures referred to in article 20, the admission of new Members, the election or removal of the General Secretary, adoption of the budget and matters related thereto. Decisions on other matters, as well as procedural questions and also determination of which questions must be decided by a two-thirds majority, shall be taken by a simple majority of the Members present and voting.

6. The General Conference shall adopt its own rules of procedure.

The Council

Article 10

1. The Council shall be composed of five Members of the Agency elected by the General Conference from among the Contracting Parties, due account being taken of equitable geographic distribution.

2. The Members of the Council shall be elected for a term of four years. However, in the first election three will be elected for two years. Outgoing Members may not be re-elected for the following period unless the limited number of States for which the Treaty is in force so requires.

3. Each Member of the Council shall have one representative.

4. The Council shall be so organized as to be able to function continuously.

5. In addition to the functions conferred upon it by this Treaty and to those which may be assigned to it by the General Conference, the Council shall, through the General Secretary, ensure the proper operation of the control system in accordance with the provisions of this Treaty and with the decisions adopted by the General Conference.

6. The Council shall submit an annual report on its work to the General Conference as well as such special reports as it deems necessary or which the General Conference requests of it.

7. The Council shall elect its officers for each session.

8. The decisions of the Council shall be taken by a simple majority of its Members present and voting.

9. The Council shall adopt its own rules of procedure.

The Secretariat

Article 11

1. The Secretariat shall consist of a General Secretary, who shall be the chief administrative officer of the Agency, and of such staff as the Agency may require. The term of office of the General Secretary shall be four years and he may be re-elected for a single additional term. The General Secretary may not be a national of the country in which the Agency has its headquarters. In case the office of General Secretary becomes vacant, a new election shall be held to fill the office for the remainder of the term.

2. The staff of the Secretariat shall be appointed by the General Secretary, in accordance with rules laid down by the General Conference.

Control system

Article 12

1. For the purpose of verifying compliance with the obligations entered into by the Contracting Parties in accordance with article 1, a control system shall be established which shall be put into effect in accordance with the provisions of articles 13-18 of this Treaty.

2. The control system shall be used in particular for the purpose of verifying:

(a) That devices, services and facilities intended for peaceful uses of nuclear energy are not used in the testing or manufacture of nuclear weapons,

(b) That none of the activities prohibited in article 1 of this Treaty are carried out in the territory of the Contracting Parties with nuclear materials or weapons introduced from abroad, and

(c) That explosions for peaceful purposes are compatible with article 18 of this Treaty.

IAEA safeguards

Article 13

Each Contracting Party shall negotiate multilateral or bilateral agreements with the International Atomic Energy Agency for the application of its safeguards to its nuclear activities. Each Contracting Party shall initiate negotiations within a period of 180 days after the date of the deposit of its instrument of ratification of this Treaty. These agreements shall enter into force, for each Party, not later than eighteen months after the date of the initiation of such negotiations except in case of unforeseen circumstances or *force majeure*.

Reports of the Parties

Article 14

1. The Contracting Parties shall submit to the Agency and to the International Atomic Energy Agency, for their information, semi-annual reports stating that no activity prohibited under this Treaty has occurred in their respective territories.

2. The Contracting Parties shall simultaneously transmit to the Agency a copy of any report they may submit to the International Atomic Energy Agency which relates to matters that are the subject of this Treaty and to the application of safeguards.

3. The Contracting Parties shall also transmit to the Organization of American States, for its information, any reports that may be of interest to it, in accordance with the obligations established by the Inter-American System.

Special reports requested by the General Secretary

Article 15

1. With the authorization of the Council, the General Secretary may request any of the Contracting Parties to provide the Agency with complementary or supplementary information regarding any event or circumstance connected with compliance with this Treaty, explaining his reasons. The Contracting Parties undertake to co-operate promptly and fully with the General Secretary.

2. The General Secretary shall inform the Council and the Contracting Parties forthwith of such requests and of the respective replies.

Special inspections

Article 16

1. The International Atomic Energy Agency and the Council established by this Treaty have the power of carrying out special inspections in the following cases:

(a) In the case of the International Atomic Energy Agency, in accordance with the agreements referred to in article 13 of this Treaty;

(b) In the case of the Council:

(i) When so requested, the reasons for the request being stated, by any Party which suspects that some activity prohibited by this Treaty has been carried out or is about to be carried out, either in the territory of any other Party or in any other place on such latter Party's behalf, the Council shall immediately arrange for such an inspection in accordance with article 10, paragraph 5.

(ii) When requested by any Party which has been suspected of or charged with having violated this Treaty, the Council shall immediately arrange for the special inspection requested in accordance with article 10, paragraph 5.

The above requests will be made to the Council through the General Secretary.

2. The costs and expenses of any special inspection carried out under paragraph 1, sub-paragraph (b), sections (i) and (ii) of this article shall be borne by the requesting Party or Parties, except where the Council concludes on the basis of the report on the special inspection that, in view of the circumstances existing in the case, such costs and expenses should be borne by the agency.

3. The General Conference shall formulate the procedures for the organization and execution of the special inspections carried out in accordance with paragraph 1, sub-paragraph (b), sections (i) and (ii) of this article.

4. The Contracting Parties undertake to grant the inspectors carrying out such special inspections full and free access to all places and all information which may be necessary for the performance of their duties and which are directly and intimately connected with the suspicion of violation of this Treaty. If so requested by the authorities of the Contracting Party in whose territory the inspection is carried out, the inspectors designated by the General Conference shall be accompanied by representatives of said authorities, provided that this does not in any way delay or hinder the work of the inspectors.

5. The Council shall immediately transmit to all the Parties, through the General Secretary, a copy of any report resulting from special inspections.

6. Similarly, the Council shall send through the General Secretary to the Secretary-General of the United Nations, for transmission to the United Nations Security Council and General Assembly, and to the Council of the Organization of American States, for its information, a copy of any report resulting from any special inspection carried out in accordance with paragraph 1, sub-paragraph (b), sections (i) and (ii) of this article.

7. The Council may decide, or any Contracting Party may request, the convening of a special session of the General Conference for the purpose of considering the reports resulting from any special inspection. In such a case, the General Secretary shall take immediate steps to convene the special session requested.

8. The General Conference, convened in special session under this article, may make recommendations to the Contracting Parties and submit reports to the Secretary-General of the United Nations to be transmitted to the United Nations Security Council and the General Assembly.

Use of nuclear energy for peaceful purposes

Article 17

Nothing in the provisions of this Treaty shall prejudice the rights of the Contracting Parties, in conformity with this Treaty, to use nuclear energy for peaceful purposes, in particular for their economic development and social progress.

Explosions for peaceful purposes

Article 18

1. The Contracting Parties may carry out explosions of nuclear devices for peaceful purposes—including explosions which involve devices similar to those used in nuclear weapons—or collaborate with third parties for the same purpose, provided that they do so in accordance with the provisions of this article and the other articles of the Treaty, particularly articles 1 and 5.

2. Contracting Parties intending to carry out, or to cooperate in carrying out, such an explosion shall notify the Agency and the International Atomic Energy Agency, as far in advance as the circumstances require, of the date of the explosion and shall at the same time provide the following information:

(a) The nature of the nuclear device and the source from which it was obtained,

(b) The place and purpose of the planned explosion,

(c) The procedures which will be followed in order to comply with paragraph 3 of this article.

(d) The expected force of the device, and

(e) The fullest possible information on any possible radioactive fall-out that may result from the explosion or explosions, and measures which will be taken to avoid danger to the population, flora, fauna and territories of any other Party or Parties.

3. The General Secretary and the technical personnel designated by the Council and the International Atomic Energy Agency may observe all the preparations, including the explosion of the device, and shall have unrestricted access to any area in the vicinity of the site of the explosion in order to ascertain whether the device and the procedures followed during the explosion are in conformity with the information supplied under paragraph 2 of this article and the other provisions of this Treaty.

4. The Contracting Parties may accept the collaboration of third parties for the purpose set forth in paragraph 1 of the present article, in accordance with paragraphs 2 and 3 thereof.

Relations with other international organizations

Article 19

1. The Agency may conclude such agreements with the International Atomic Energy Agency as are authorized by the General Conference and as it considers likely to facilitate the efficient operation of the control system established by this Treaty.

2. The Agency may also enter into relations with any international organization or body, especially any which may be established in the future to supervise disarmament or measures for the control of armaments in any part of the world.

3. The Contracting Parties may, if they see fit, request the advice of the Inter-American Nuclear Energy Commission on all technical matters connected with the application of this Treaty with which the Commission is competent to deal under its Statute.

Measures in the event of violation of the Treaty

Article 20

1. The General Conference shall take note of all cases in which, in its opinion, any Contracting Party is not complying fully with its obligations under this Treaty and shall draw the matter to the attention of the Party concerned, making such recommendations as it deems appropriate.

2. If, in its opinion, such non-compliance constitutes a violation of this Treaty which might endanger peace and security, the General Conference shall report thereon simultaneously to the United Nations Security Council and the General Assembly through the Secretary-General of the United Nations, and to the Council of the Organization of American States. The General Conference shall likewise report to the International Atomic Energy Agency for such purposes as are relevant in accordance with its Statute.

Treaty for the Prohibition of Nuclear Weapons in Latin America

Country	Date of Signature	Date of Deposit of Ratification
Argentina	9/27/67	
Bahamas, The		7/16/76[a]
Barbados	10/18/68	4/25/69
Bolivia	2/14/67	2/18/69
Brazil	5/ 9/67	1/29/68[b]
Chile	2/14/67	10/ 9/74[b]
Colombia	2/14/67	8/ 4/72
Costa Rica	2/14/67	8/25/69
Dominican Republic	7/29/67	6/14/68
Ecuador	2/14/67	2/11/69
El Salvador	2/14/67	4/22/68
Grenada	4/29/75	6/20/75
Guatemala	2/14/67	2/ 6/70
Haiti	2/14/67	5/23/69
Honduras	2/14/67	9/23/68
Jamaica	10/26/67	6/26/69
Mexico	2/14/67	9/20/67
Nicaragua	2/15/67	10/24/68
Panama	2/14/67	6/11/71
Paraguay	4/26/67	3/19/69
Peru	2/14/67	3/ 4/69
Suriname	2/13/76	6/10/77
Trinidad & Tobago	6/27/67	12/ 3/70[c]
Uruguay	2/14/67	8/20/68
Venezuela	2/14/67	3/23/70
Total	24	24

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[a] This is date of notification of succession. The declaration of waiver was deposited 4/26/77, which is date of entry into force for The Bahamas.

[b] Not in force. No declaration of waiver under Art. 28, para. 2.

[c] The declaration of waiver was deposited 6/27/75, which is date of entry into force for Trinidad and Tobago.

Additional Protocol I to the Treaty for the Prohibition of Nuclear Weapons in Latin America

Country	Date of Signature	Date of Deposit of Ratification
France	3/2/79	
Netherlands	4/ 1/68	7/26/71
United Kingdom	12/20/67	12/11/69
United States	5/26/77	11/23/81

Additional Protocol II to the Treaty for the Prohibition of Nuclear Weapons in Latin America

Country	Date of Signature	Date of Deposit of Ratification
China, People's Republic of	8/21/73	6/12/74
France	7/18/73	3/22/74
Union of Soviet Socialist Republics	5/18/78	1/ 8/79
United Kingdom	12/20/67	12/11/69
United States	4/ 1/68	5/12/71

Treaty on the Non-Proliferation of Nuclear Weapons

Signed at Washington, London, and Moscow July 1, 1968
Ratification advised by U.S. Senate March 13, 1969
Ratified by U.S. President November 24, 1969
U.S. ratification deposited at Washington, London, and Moscow March 5, 1970
Proclaimed by U.S. President March 5, 1970
Entered into force March 5, 1970

The States concluding this Treaty, hereinafter referred to as the "Parties to the Treaty",

Considering the devastation that would be visited upon all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples,

Believing that the proliferation of nuclear weapons would seriously enhance the danger of nuclear war,

In conformity with resolutions of the United Nations General Assembly calling for the conclusion of an agreement on the prevention of wider dissemination of nuclear weapons,

Undertaking to cooperate in facilitating the application of International Atomic Energy Agency safeguards on peaceful nuclear activities,

Expressing their support for research, development and other efforts to further the application, within the framework of the International Atomic Energy Agency safeguards system, of the principle of safeguarding effectively the flow of source and special fissionable materials by use of instruments and other techniques at certain strategic points,

Affirming the principle that the benefits of peaceful applications of nuclear technology, including any technological by-products which may be derived by nuclear-weapon States from the development of nuclear explosive devices, should be available for peaceful purposes to all Parties of the Treaty, whether nuclear-weapon or non-nuclear weapon States,

Convinced that, in furtherance of this principle, all Parties to the Treaty are entitled to participate in the fullest possible exchange of scientific information for, and to contribute alone or in cooperation with other States to, the further development of the applications of atomic energy for peaceful purposes,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament,

Urging the cooperation of all States in the attainment of this objective,

Recalling the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end,

Desiring to further the easing of international tension and the strengthening of trust between States in order to facilitate the cessation of the manufacture of nuclear weapons, the liquidation of all their existing stockpiles, and the elimination from national arsenals of nuclear weapons and the means of their delivery pursuant to a treaty on general and complete disarmament under strict and effective international control, Recalling that, in accordance with the Charter of the United Nations, States must refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purposes of the United Nations, and that the establishment and maintenance of international peace and security are to be promoted with the least diversion for armaments of the world's human and economic resources,

Have agreed as follows:

Article I

Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

Article II

Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

Article III

1. Each non-nuclear-weapon State Party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agency's safeguards system, for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. Procedures for the safeguards required by this article shall be followed with respect to source or special fissionable material whether it is being produced, processed or used in any principal nuclear facility or is outside any such facility. The safeguards required by this article shall be applied to all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.

2. Each State Party to the Treaty undertakes not to provide: (a) source or special fissionable material, or (b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this article.

3. The safeguards required by this article shall be implemented in a manner designed to comply with article IV of this Treaty, and to avoid hampering the economic or technological development of the Parties or international cooperation in the field of peaceful nuclear activities, including the international exchange of nuclear material and equipment for the processing, use or production of nuclear material for peaceful purposes in accordance with the provisions of this article and the principle of safeguarding set forth in the Preamble of the Treaty.

4. Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this article either

individually or together with other States in accordance with the Statute of the International Atomic Energy Agency. Negotiation of such agreements shall commence within 180 days from the original entry into force of this Treaty. For States depositing their instruments of ratification or accession after the 180-day period, negotiation of such agreements shall commence not later than the date of such deposit. Such agreements shall enter into force not later than eighteen months after the date of initiation of negotiations.

Article IV

1. Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with articles I and II of this Treaty.

2. All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also cooperate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.

Article V

Each party to the Treaty undertakes to take appropriate measures to ensure that, in accordance with this Treaty, under appropriate international observation and through appropriate international procedures, potential benefits from any peaceful applications of nuclear explosions will be made available to non-nuclear-weapon States Party to the Treaty on a nondiscriminatory basis and that the charge to such Parties for the explosive devices used will be as low as possible and exclude any charge for research and development. Non-nuclear-weapon States Party to the Treaty shall be able to obtain such benefits, pursuant to a special international agreement or agreements, through an appropriate international body with adequate representation of non-nuclear-weapon States. Negotiations on this subject shall commence as soon as possible after the Treaty enters into force. Non-nuclear-weapon States Party to the Treaty so desiring may also obtain such benefits pursuant to bilateral agreements.

Article VI

Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

Article VII

Nothing in this Treaty affects the right of any group of States to conclude regional treaties in order to assure the total absence of nuclear weapons in their respective territories.

Article VIII

1. Any Party to the Treaty may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments which shall

circulate it to all Parties to the Treaty. Thereupon, if requested to do so by one-third or more of the Parties to the Treaty, the Depositary Governments shall convene a conference, to which they shall invite all the Parties to the Treaty, to consider such an amendment.

2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to the Treaty, including the votes of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. The amendment shall enter into force for each Party that deposits its instrument of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties, including the instruments of ratification of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. Thereafter, it shall enter into force for any other Party upon the deposit of its instrument of ratification of the amendment.

3. Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realized. At intervals of five years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the Depositary Governments, the convening of further conferences with the same objective of reviewing the operation of the Treaty.

Article IX

1. This Treaty shall be open to all States for signature. Any State which does not sign the Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force after its ratification by the States, the Governments of which are designated Depositaries of the Treaty, and forty other States signatory to this Treaty and the deposit of their instruments of ratification. For the purposes of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to January 1, 1967.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession, the date of the entry into force of this Treaty, and the date of receipt of any requests for convening a conference or other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to article 102 of the Charter of the United Nations.

Article X

1. Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of

such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

2. Twenty-five years after the entry into force of the Treaty, a conference shall be convened to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods. This decision shall be taken by a majority of the Parties to the Treaty.

Article XI

This Treaty, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Treaty.

DONE in triplicate, at the cities of Washington, London and Moscow, this first day of July one thousand nine hundred sixty-eight.

NPT Newsletter

As of 1 November 1982, the International Atomic Energy Agency had negotiated safeguards agreements with 81 non-nuclear-weapon States party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Safeguards agreements were in force with 74 of these States. Safeguards agreement with a further 7 non-nuclear-weapon States which had been approved by the IAEA Board of Governors were awaiting entry into force. The date in parentheses after the name of the State indicates the time by which the NPT safeguards agreement should have entered or should enter into force.

NON-NUCLEAR-WEAPON STATES PARTY TO NPT

1. **Afghanistan**
2. *Antigua and Barbuda (1 November 83)*
3. **Australia**
4. **Austria**
5. *Bahamas (10 January 75)*
6. **Bangladesh**
7. *Barbados (21 August 81)*
8. **Belgium**
9. *Benin (30 April 74)*
10. *Bolivia* (5 March 72)*
11. *Botswana (5 March 72)*
12. **Bulgaria**
13. *Burundi (19 September 72)*
14. **Canada**
15. *Cape Verde (24 April 1981)*
16. *Central African Republic (25 April 72)*
17. *Chad (10 September 72)*
18. *Congo (23 April 80)*
19. **Costa Rica**
20. **Cyprus**
21. **Czechoslovakia**
22. *Democratic Kampuchea (2 December 73)*
23. *Democratic Yemen (1 December 80)*
24. **Denmark**
25. **Dominican Republic**
26. **Ecuador**
27. **Egypt**
28. **El Salvador**
29. **Ethiopia**
30. **Fiji**
31. **Finland**
32. *Gabon* (7 Auaust 75)*
33. **Gambia**
34. **German Democratic Republic**
35. **Germany, Federal Republic of**
36. **Ghana**
37. **Greece**
38. *Grenada (19 February 76)*
39. **Guatemala**
40. *Guinea Bissau (20 February 78)*
41. *Haiti* (2 June 72)*
42. **Holy See**
43. **Honduras**
44. **Hungary**
45. **Iceland**
46. **Indonesia**
47. **Iran**
48. **Iraq**
49. **Ireland**
50. **Italy**
51. *Ivory Coast (6 September 74)*
52. **Jamaica**
53. **Japan**
54. **Jordan**
55. *Kenya (5 March 72)*
56. **Korea, Republic of**
57. *Lao People's Democratic Republic (5 March 72)*
58. **Lebanon**
59. **Lesotho**
60. *Liberia (5 March 72)*
61. **Libyan Arab Jamahiriya**
62. **Liechtenstein**
63. **Luxembourg**
64. **Madagascar**
65. **Malaysia**
66. **Maldives**
67. *Mali (5 March 72)*
68. *Malta (5 March 72)*
69. **Mauritius**
70. **Mexico**
71. **Mongolia**
72. **Morocco**
73. **Nepal**
74. **Netherlands**
75. **New Zealand**
76. **Nicaragua**
77. *Nigeria (5 March 72)*
78. **Norway**
79. *Panama (13 July 78)*
80. *Papua New Guinea (25 January 84)*
81. **Paraguay**
82. **Peru**
83. **Philippines**
84. **Poland**
85. **Portugal**
86. **Romania**
87. *Rwanda (20 November 76)*
88. *St. Lucia (29 June 81)*
89. **Samoa**
90. *San Marino* (5 March 72)*
91. **Senegal**
92. *Sierra Leone* (26 August 76)*
93. **Singapore**
94. *Solomon islands (17 June 1981)*
95. *Somalia (5 March 72)*
96. *Sri Lanka* (5 September 80)*
97. **Sudan**
98. **Suriname**
99. **Swaziland**
100. **Sweden**
101. **Switzerland**
102. *Syrian Arab Republic (5 March 72)*
103. **Thailand**
104. *Togo (5 March 72)*
105. *Tonga* (7 January 73)*
106. *Tunisia (5 March 72)*
107. **Turkey**
108. *Tuvalu (19 July 80)*
109. *United Republic of Cameroon (5 March 72)*
110. *Upper Volta (5 March 72)*
111. **Uruguay**
112. **Venezuela**
113. **Yugoslavia**
114. **Zaire**

[115. *"Republic of China" – 5 March 72*]
The "Republic of China" has ratified the NPT.

Change since previous Newsletter:

The Solomon Islands succeeded to the NPT on 17 June 1981.

Note: **Bold:** States having NPT safeguards agreement in force.
Italics: States not having NPT safeguards agreements in force.
*: Safeguards agreement approved by the IAEA Board of Governors and awaiting entry into force.

THE INTERNATIONAL ATOMIC ENERGY AGENCY

An Appraisal with Recommendations for United States Policy

E PLURIBUS
UNUM

A Report to the Secretary of State
of the Panel to Review the Activities of the International Atomic Energy Agency

1972

ABSTRACT

A Panel to develop recommendations as to how United States policy objectives can be achieved through the activities of the International Atomic Energy Agency was established by the Secretary of State in April 1971. The three major policy recommendations of the Panel are:

1. The United States Government should reaffirm by repeated statements and by continuing action its vigorous support of the International Atomic Energy Agency especially because of its critical role in carrying out the provisions of the Treaty on the Non-Proliferation of Nuclear Weapons.

2. The United States Government should urge the IAEA to retain a balance in its programs that will demonstrate to all Member States that they benefit from its activities--small nations as well as large, developing nations as well as developed nations.

3. The significance of a strong IAEA is of such major importance to United States and world objectives that its effectiveness should not be limited by indiscriminate budget restrictions. The Agency's performance in fiscal management has been conservative and efficient. To insure achievement of the high priority safeguards program may require the development of alternative budgetary practices within the United States Government to protect the overall Agency program from across-the-board cuts which may be applied from time to time to all international organizations.

In addition to the foregoing *policy* recommendations, the Panel developed a substantial number of specific conclusions and recommendations concerning the *programs* and *operations* of the IAEA. These may be summarized under the following seven headings:

1. A fully effective nuclear, non-proliferation safeguards program will require, in addition to adequate budget support, a modest but highly competent in-house related research effort and reasonably long-term career type appointments for inspectors.

2. Technical assistance activities should be maintained at least at the present relative level (with respect to the other Agency programs) and be guided by a strong planning and analysis staff to evaluate the effectiveness of assistance projects and optimize the selection of new ones.

3. The Agency's work in health and safety and related standards development must keep pace with the growing use of atomic energy throughout the world.

4. As more nations become involved in sharing the benefits of atomic energy, the IAEA has a unique opportunity to serve simultaneously as an expert advisor and a neutral arbiter on such matters as power plant selection, power plant location, radioactivity monitoring, safety surveys and nuclear waste management.

5. The Agency's research program must continue to try to meet the needs of developing nations. In the applied research and development area the possibility of small nuclear

power plants for small nations affords a special opportunity.

6. It is important for the IAEA to maintain an alert readiness capability for serving potential new developments and applications such as thermonuclear power and the use of peaceful nuclear explosions.

7. Increased cooperation by IAEA with other international organizations is necessary in order to improve the dissemination of the potential benefits of atomic energy on a worldwide basis.

SUMMARY OF CONCLUSIONS

General

1. The activities of the International Atomic Energy Agency are of vital importance to the security and well-being of all the nations of the world. The Agency's responsibilities include simultaneously (a) the implementation of a successful non-proliferation safeguards program to deter the diversion of nuclear material from peaceful uses to the development of atomic weapons, and (b) the dissemination of the peaceful benefits of atomic energy to all nations. These two aspects of the Agency's programs are complementary and mutually reinforcing and must be kept in reasonable balance.

2. It is essential that the Agency have wide acceptance and strong support among its member nations in order to assure the effective fulfillment of its responsibilities and its promise in the avoidance of proliferation of nuclear weapons.

3. The Agency has been one of the most successful of the intergovernmental organizations. This, in the Panel's judgment, is a consequence partly of the conservative and efficient management of the Agency and partly because of the high world-wide interest in international nuclear science and technology, which in turn has helped to minimize political polemics in the Agency.

4. The services provided by the Agency have been of significant benefit to substantially all of the member nations, the highly developed countries as well as the developing countries. It is important that this diversification and balance of services, centered around the development and exploitation of the peaceful benefits of atomic energy, be maintained.

Budget

The Agency's budget and its rate of growth are very modest either in relation to that of other international organizations or in relation to the great significance of the Agency's program to world peace and security. In the Panel's judgment, the present ratios of assessment among the member nations are reasonable and the allocation of funds to various programs well balanced. The total level of the budget should be based firmly on the requirement for carrying out effective programs. The achievement and maintenance of such a level may well require very special efforts within the Board of Governors and the General Conference. In the formulation of United States policy for the Agency, particular care should be exercised to prevent the application of indiscriminate across-the-board cuts to the Agency.

Management and Staffing

The IAEA is an effective, well-run organization by comparison with most international organizations. The conservative nature of the Agency's management has engendered confidence among most of the member nations.

The Agency's staff, with few exceptions, has been composed of high quality individuals. The policy of short-term appointment has contributed in part to this record. In addition the statute of the Agency, which gives priority to the qualifications of appointees rather than to national quotas, has helped. There have however been instances where undue attention to geographical distribution of staff has resulted in weak appointments.

The quality and level of U.S. participation in the affairs of IAEA, primarily through its Mission in Vienna, has been an important factor in the success of the Agency. However, the relative number of U.S. citizens on the staff of the Agency is less than the Panel considers appropriate.

The Director General's Science Advisory Committee does not now appear to play as significant a role in the affairs of the Agency as it did during its first few years. The Panel has concluded that it would be desirable to redefine the role and membership of this potentially important Committee.

Programs

1. Safeguards. The nuclear non-proliferation safeguards program is the indispensable reason for the existence of the IAEA. Safeguards, however, cannot succeed, in the Panel's judgment, without effective complementary programs which develop and disseminate the potential benefits of

atomic energy. Furthermore, a weak or marginal safeguards program would probably be worse than no safeguards at all because it would tend to further a false sense of security. An effective safeguards program requires a fully adequate budget (not diverted from other Agency programs) and a strong, highly competent, dedicated staff together with an effective but modest in-house research program aimed at improving safeguards technology.

2. Technical Assistance. A critical evaluation of the effectiveness of the Agency's technical assistance program by the Panel was not possible within the time and manpower resources available to it. The Panel believes that such an evaluative process should be built into the Agency's planning capability for the future. It is nevertheless the Panel's impression that the Agency's technical assistance activities have been very successful in improving the scientific and technological competence of many developing countries, and that this is an essential foundation for future economic development. In a sense, all of the Agency's programs may be considered as "technical assistance" since they are aimed at improving the capabilities of all nations, developed as well as developing, to use atomic energy constructively, efficiently and safely.

3. Information. The Agency's information activities, including publications, conferences, and panels have been very useful in improving and extending technical interchange among nations, particularly between the USSR and other Eastern European countries and the United States and Western Europe. The effort to evolve a truly international nuclear information system, INIS, is of potentially high significance.

4. Health and Safety. The codes of safe practices developed under the Agency's auspices, as part of its Health and Safety Program, have provided guidance for countries at all levels of development (including the U.S.) and their pervasive influence can be expected to continue to affect research, medical, and industrial practice in nuclear energy throughout the world.

As the use of nuclear power spreads throughout the world, more and more nations will find it necessary to call upon the services of an independent, objective body for broad-based safety evaluations. The Panel believes that the health and safety responsibilities of the Agency should involve much more than practices for handling radioactive material in laboratories and power plants. They should embrace broad environmental matters, such as power plant site selection, waste management and radioactivity surveys. Although such evaluations have been a low level activity in the past, the demand is expected to grow rapidly in the near future.

5. Research. The research contract program of the Agency has pursued two major goals--obtaining information needed by member States, and providing a form of technical assistance to developing states through contracts. The Panel concludes that both these goals are proper, that the present mix achieved by the Agency is wise, and that the execution of the research program is sound.

Research projects at the Agency's laboratory at Seibersdorf, Monaco, and the Institute for Theoretical Physics have made significant but not outstanding contributions in their fields. Operation of these centers is not based on research contributions alone, but is to give broad technical competence and political support to the Agency's programs. Together, these reasons constitute more than adequate justification for the existence of the facilities. The need for more safeguards technology research gives' added significance to the Seibersdorf facility.

The program of the IAEA has included a minor effort on small-and medium-size power reactors suitable for the needs of developing countries. Research of this type has received little attention from the large industrial countries, whose programs have emphasized large systems for which economies of scale are significant. The Panel concludes that the present world situation calls for an increased effort to develop economical power reactors of sizes less than 400 megawatts electrical.

The Panel believes that there will be increasing need for the Agency to serve as an expert, objective international advisor and arbiter on matters involving the use of nuclear energy and trade in nuclear materials. It is important that the Agency (a) develop a competence to fill this growing need and (b) take precautions to insure that the need for objectivity prevails over the Agency's interest in promoting the peaceful use of atomic energy.

Relations With Other International Agencies

Since the Panel believes that the focus of the Agency's activities is and should remain "atomic energy" and that atomic energy, judiciously used, will increasingly afford the means by which many of mankind's social and economic needs can be best provided, it is essential that the IAEA develop close cooperation programs with those other international agencies with more direct responsibility for dealing with social and economic problems. It is the Panel's judgment that the arrangements already employed with the Food and Agriculture Organization have been effective.

Development of United States Policy

The broad interaction of atomic energy with matters of important concern to an increasing number of United States departments and agencies requires broad participation in the development of policy positions toward the Agency. In the Panel's judgment, the reconciliation of diverse interests has been reasonably effective in the past. The significance of the rapidly increasing world-wide use of atomic energy may make the problem of formulating wise policy a matter of growing difficulty and importance in the future.

MEMBERS OF THE PANEL

Allen V. Astin, Director Emeritus, National Bureau of Standards, Chairman

Cyril L. Comar, Professor and Head of Department of Physical Biology, New York State Veterinary College, Cornell University

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EXCERPT

Public Law 95-242
95th Congress

An Act

Mar. 10, 1978
[H.R. 8638]

To provide for more efficient and effective control over the proliferation of nuclear explosive capability.

Nuclear Non-Proliferation Act of 1978.
22 USC 3201 note.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Nuclear Non-Proliferation Act of 1978".

STATEMENT OF POLICY

22 USC 3201.

SEC. 2. The Congress finds and declares that the proliferation of nuclear explosive devices or of the direct capability to manufacture or otherwise acquire such devices poses a grave threat to the security interests of the United States and to continued international progress toward world peace and development. Recent events emphasize the urgency of this threat and the imperative need to increase the effectiveness of international safeguards and controls on peaceful nuclear activities to prevent proliferation. Accordingly, it is the policy of the United States to—

(a) actively pursue through international initiatives mechanisms for fuel supply assurances and the establishment of more effective international controls over the transfer and use of nuclear materials and equipment and nuclear technology for peaceful purposes in order to prevent proliferation, including the establishment of common international sanctions;

(b) take such actions as are required to confirm the reliability of the United States in meeting its commitments to supply nuclear reactors and fuel to nations which adhere to effective non-proliferation policies by establishing procedures to facilitate the timely processing of requests for subsequent arrangements and export licenses;

(c) strongly encourage nations which have not ratified the Treaty on the Non-Proliferation of Nuclear Weapons to do so at the earliest possible date; and

(d) cooperate with foreign nations in identifying and adapting suitable technologies for energy production and, in particular, to identify alternative options to nuclear power in aiding such nations to meet their energy needs, consistent with the economic and material resources of those nations and environmental protection.

STATEMENT OF PURPOSE

22 USC 3202.

SEC. 3. It is the purpose of this Act to promote the policies set forth above by—

(a) establishing a more effective framework for international cooperation to meet the energy needs of all nations and to ensure that the worldwide development of peaceful nuclear activities and the export by any nation of nuclear materials and equipment and nuclear technology intended for use in peaceful nuclear activities do not contribute to proliferation;

(b) authorizing the United States to take such actions as are required to ensure that it will act reliably in meeting its commitment to supply nuclear reactors and fuel to nations which adhere to effective non-proliferation policies;

(c) providing incentives to the other nations of the world to join in such international cooperative efforts and to ratify the Treaty; and

(d) ensuring effective controls by the United States over its exports of nuclear materials and equipment and of nuclear technology.

TITLE II—UNITED STATES INITIATIVES TO STRENGTHEN THE INTERNATIONAL SAFEGUARDS SYSTEM

POLICY

22 USC 3241. SEC. 201. The United States is committed to continued strong support for the principles of the Treaty on the Non-Proliferation of Nuclear Weapons, to a strengthened and more effective International Atomic Energy Agency and to a comprehensive safeguards system administered by the Agency to deter proliferation. Accordingly, the United States shall seek to act with other nations to—

(a) continue to strengthen the safeguards program of the IAEA and, in order to implement this section, contribute funds, technical resources, and other support to assist the IAEA in effectively implementing safeguards;

(b) ensure that the IAEA has the resources to carry out the provisions of Article XII of the Statute of the IAEA;

(c) improve the IAEA safeguards system (including accountability) to ensure—

(1) the timely detection of a possible diversion of source or special nuclear materials which could be used for nuclear explosive devices;

(2) the timely dissemination of information regarding such diversion; and

(3) the timely implementation of internationally agreed procedures in the event of such diversion;

(d) ensure that the IAEA receives on a timely basis the data needed for it to adminster an effective and comprehensive international safeguards program and that the IAEA provides timely notice to the world community of any evidence of a violation of any safeguards agreement to which it is a party; and

(e) encourage the IAEA, to the maximum degree consistent with the Statute, to provide nations which supply nuclear materials and equipment with the data needed to assure such nations of adherence to bilateral commitments applicable to such supply.

TRAINING PROGRAM

22 USC 3242. SEC. 202. The Department of Energy, in consultation with the Commission, shall establish and operate a safeguards and physical security training program to be made available to persons from nations and groups of nations which have developed or acquired, or may be expected to develop or acquire, nuclear materials and equipment for use for peaceful purposes. Any such program shall include training in the most advanced safeguards and physical security techniques and technology, consistent with the national security interests of the United States.

NEGOTIATIONS

22 USC 3243. SEC. 203. The United States shall seek to negotiate with other nations and groups of nations to—

(1) adopt general principles and procedures, including common international sanctions, to be followed in the event that a nation violates any material obligation with respect to the peaceful use of nuclear materials and equipment or nuclear technology, or in

the event that any nation violates the principles of the Treaty, including the detonation by a non-nuclear-weapon state of a nuclear explosive device; and

(2) establish international procedures to be followed in the event of diversion, theft, or sabotage of nuclear materials or sabotage of nuclear facilities, and for recovering nuclear materials that have been lost or stolen, or obtained or used by a nation or by any person or group in contravention of the principles of the Treaty.

IAEA/SG/INF/3

IAEA SAFEGUARDS
AN INTRODUCTION

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1981

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN
ALBANIA
ALGERIA
ARGENTINA
AUSTRALIA
AUSTRIA
BANGLADESH
BELGIUM
BOLIVIA
BRAZIL
BULGARIA
BURMA
BYELORUSSIAN SOVIET SOCIALIST REPUBLIC
CANADA
CHILE
COLOMBIA
COSTA RICA
CUBA
CYPRUS
CZECHOSLOVAKIA
DEMOCRATIC KAMPUCHEA
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
DENMARK
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ETHIOPIA
FINLAND
FRANCE
GABON
GERMAN DEMOCRATIC REPUBLIC
GERMANY, FEDERAL REPUBLIC OF
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN
IRAQ
IRELAND
ISRAEL
ITALY
IVORY COAST
JAMAICA
JAPAN
JORDAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
LEBANON
LIBERIA
LIBYAN ARAB JAMAHIRIYA
LIECHTENSTEIN
LUXEMBOURG
MADAGASCAR
MALAYSIA
MALI
MAURITIUS
MEXICO
MONACO
MONGOLIA
MOROCCO
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
PAKISTAN
PANAMA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
ROMANIA
SAUDI ARABIA
SENEGAL
SIERRA LEONE
SINGAPORE
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
THAILAND
TUNISIA
TURKEY
UGANDA
UKRAINIAN SOVIET SOCIALIST REPUBLIC
UNION OF SOVIET SOCIALIST REPUBLICS
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF CAMEROON
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
VENEZUELA
VIET NAM
YUGOSLAVIA
ZAIRE
ZAMBIA

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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IAEA SAFEGUARDS

AN INTRODUCTION

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 1981

FOREWORD

The IAEA Safeguards Information Series is intended to provide information on IAEA safeguards and related subjects. It is hoped that it will be of help to, inter alia, facility operators, design engineers and, since it is not excessively technical, also to certain civil service and external relations staff, and journalists.

The purpose of this third booklet in the Series is to give a general picture of the objectives and methods of safeguards, and of their role in non-proliferation policy.

The two previous booklets published in the IAEA Safeguards Information Series are as follows: IAEA/SG/INF/1 is a Glossary of Safeguards terms providing definitions which may be useful to the reader with a deeper interest in the subject; IAEA/SG/INF/2 is of a more specialized nature containing guidelines for States' Systems of Accounting for and Control of Nuclear Materials.

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NON-PROLIFERATION AND SAFEGUARDS

Historical

The concept of safeguards

Until the Second World War, agreements and treaties between nations generally rested on the good faith of the parties to the agreement, and did not provide for any means to verify that they were fulfilling the obligations they had accepted. The advent of nuclear energy changed this. Since the early 1950s, when States began to trade in nuclear materials and equipment for peaceful purposes, it has become the practice (and is today the invariable practice) for international agreements dealing with the use of nuclear energy to specify a set of 'safeguards' to verify systematically that the State or States concerned will not use the relevant nuclear materials or equipment for purposes or in a manner proscribed by the agreement. In the case of IAEA safeguards the prohibition generally relates to any explosive and any military use of nuclear material, equipment, etc.

This insistence on rigorous *verification* reflects chiefly the fact that nuclear energy can be used for military as well as peaceful purposes and, in particular, that certain nuclear materials can, in addition to their peaceful applications, be used as the explosive charge of nuclear weapons. A breach of the agreement might thus have far-reaching consequences for the parties themselves and for international security in general. The value of nuclear materials (and the radiation risks they may involve) also calls for precise accounting and other verification measures.

The first proposals

Soon after Hiroshima the United States of America proposed to the newly created United Nations that it should set up an international authority that would control all nuclear material throughout the world and all forms of nuclear activity. By its very first Resolution the General Assembly established a United Nations Atomic Energy Commission to study this proposal (known as the Baruch Plan) and to "deal with the problems raised by the discovery of atomic energy". The Soviet Union called for the destruction and prohibition of all atomic weapons before setting up a system of control.

The USA subsequently modified the Baruch Plan; only the sensitive steps in the nuclear fuel cycle (reprocessing and enrichment) should be owned and operated by an international authority while other activities should be subject to safeguards to ensure that they were not turned to military use. Despite these modifications, the Baruch Plan still called for too far-reaching a surrender of natural sovereignty to be accepted at that time.

The negotiations in the United Nations Atomic Energy Commission reached an impasse in the late 1940s and the Commission was dissolved in 1952. Prospects for a world truly free of nuclear weapons faded with the demise of the Commission and attention turned to the more restricted goal of limiting the number of nuclear-weapon States. Of the two concepts inherent in the Baruch Plan, that of safeguards to verify peaceful use survived and eventually became a cornerstone of all international agreements in the nuclear field. The concept of international operation of sensitive facilities did not bear fruit at the time but it was revived thirty years later and it is still being discussed.

The International Atomic Energy Agency

In 1953 the USA proposed the establishment of an International Atomic Energy Agency (IAEA) which would spread the benefits of nuclear technology[1] in return for an undertaking by each Member State to use it for peaceful purposes only and to accept safeguards to verify this undertaking. After three years of negotiations this concept was eventually reflected in a crucial article of the IAEA's statute which authorized it "to establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose and to apply safeguards at the request of the parties, to any bilateral or multilateral arrangement or at the request of a State, to any of that State's activities in the field of atomic energy". The Statute came into force in 1957 and the IAEA began work, at Vienna, in the same year.

At the same time the USA, the USSR and other leading industrial countries began to conclude agreements for the transfer of nuclear technology, plant and material to other countries. Most of these agreements required the importing country to accept the safeguards of the exporter on the items supplied; in other words, to report regularly on the use made of these items and to accept inspectors to verify the use of the material. In 1956 the countries of the European Communities agreed to establish a regional system of safeguards ('Euratom' safeguards).

From 1957 until 1964 little was done to activate the IAEA's safeguards. By the end of that period all five permanent members of the UN Security Council, China, France, the USSR, the USA and the United Kingdom, had tested nuclear weapons. It was clear that neither strict controls on the transfer of technology nor safeguards applied by exporting countries had been effective in preventing the spread of nuclear weapons.

---

[1] Although no nuclear power plant was in operation in 1953 it was already foreseen that nuclear power would become a major producer of electricity.

In 1965 the first major step was taken to develop systematically the IAEA's safeguards by adopting a safeguards system to replace an earlier one which covered only reactors. This new system, which was extended in 1966 and 1968 (IAEA document INFCIRC/66 Rev.2), is still applied in safeguards agreements with the 10 non-nuclear-weapon countries that have nuclear programmes and that have not expressly submitted all their nuclear activities to IAEA safeguards as they would have been required to do if they had been parties to the NPT or Tlatelolco Treaty (see below).

Most of the safeguards agreements with these 10 countries have resulted from decisions to transfer to the IAEA the responsibility for applying the safeguards prescribed in earlier bilateral agreements for the supply of nuclear plant and materials. In six of the 10 cases they cover all known nuclear plant in the country concerned, but unlike NPT safeguards (see below) they leave the country legally free to build *unsafeguarded* facilities and to produce *unsafeguarded* nuclear material.

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

Prolonged negotiations at the United Nations' Eighteen Nation Disarmament Committee finally bore fruit in 1968 in an agreement on the text of a treaty designed explicitly to prevent the spread of nuclear weapons – the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The treaty was subsequently endorsed by the General Assembly and entered into force in May 1970.

Each non-nuclear-weapon State that becomes party to the NPT binds itself not to acquire nuclear weapons or other nuclear explosives (Article II). It also binds itself to conclude an agreement with the IAEA for the application of safeguards to all its peaceful nuclear activities with a view to verifying the fulfilment of its obligations under the Treaty (Article III). In return the Treaty recognizes the right of all Parties to participate in the fullest possible exchange of equipment, materials, and scientific and technological information for the peaceful uses of nuclear energy; in other words all Parties are guaranteed full access to peaceful nuclear technology (Article IV). The Parties also undertake to pursue negotiations in good faith towards nuclear disarmament (Article VI) and re-affirm their determination to achieve the discontinuance of all tests of nuclear weapons (Preamble); these commitments obviously apply principally to the nuclear-weapon States themselves, who alone, under the Treaty, may develop and test nuclear weapons.

Several of the concepts reflected in the NPT had already been incorporated into a regional Treaty for the Prohibition of Nuclear Weapons in Latin America, which the Latin American countries had negotiated and opened for signature in February 1967. This treaty is known as the Tlatelolco Treaty after the location in Mexico where it was concluded.[2]

NPT safeguards

To carry out the safeguards obligations assigned to the IAEA by the NPT it was clearly necessary for the IAEA to devise a safeguards system appropriate for the entire fuel cycle of the advanced industrial countries that were expected to join the Treaty. This NPT safeguards system,which was drawn up during 1970 and approved by the IAEA Board of Governors in the same year, is set forth in IAEA document INFCIRC/153 (corrected).

Acceptance of the NPT and the safeguards that go with it obviously entails a significant concession of national sovereignty, and during the first half of the 1970s the issue was debated extensively in the main industrial non-nuclear-weapon States. The interests of the Common Market countries and of Japan were reconciled in safeguards agreements concluded between them and the IAEA. The ratifications of these agreements followed in 1977, thus bringing the main industrial non-nuclear-weapon States under IAEA safeguards.

Meanwhile, in 1974 a nuclear device was exploded by India, which was not then and still in 1981 is not party to the NPT. Furthermore, the nuclear material used for the Indian device had not been under IAEA safeguards. Nevertheless this event led to some doubts about the adequacy of the international safeguards regime and the NPT. These doubts were reflected subsequently in an informal agreement between supplying countries to apply the so-called 'London guidelines' of 1978, and also in United States legislation approved by Congress in 1978 which sought to restrict the export (and use) of reprocessing and other technologies considered to be sensitive. In other words, supply conditions additional to the safeguards of the NPT were imposed. The United States legislation referred to also required the renegotiation of many existing supply agreements.

A division of interest between the supplying countries and receiving countries thus emerged in the mid-1970s. On the initiative of the USA it was accordingly agreed in Washington in 1977 to launch a general international evaluation, without preconditions, of the technical assumptions concerning the development of the nuclear fuel cycle on which the nuclear energy programmes of many countries had been based since the 1950s. This International Nuclear Fuel Cycle Evaluation (INFCE) came to an end in March 1980 after an exhaustive examination of all aspects of the nuclear fuel cycle. From the work of INFCE it was clear that there is no easy technical means of preventing the acquisition of nuclear explosive material nor is it possible to rank various fuel cycles according to the risk of proliferation they entail; proliferation should rather be regarded as a political problem to be dealt with by creating new institutional and internationally acceptable measures and, above all, by improving and strengthening the international safeguards system.

---

[2] The Tlatelolco Treaty is in some respects more comprehensive than the NPT since it is designed to ensure the *total* absence of nuclear weapons in the region that it covers.

In the meantime the IAEA had embarked on a number of studies on additional institutional measures to reduce the risks of proliferation. It had completed a comprehensive study of the benefits and problems involved in setting up multinational fuel cycle centres, in which certain sensitive stages in the nuclear fuel cycle would be owned and operated by groups of nations. Another ongoing study seeks to activate a safeguards measure foreseen in Article XII.A.5 of the Agency's statute under which the IAEA has the authority to require to be deposited with it any excess of plutonium over that needed by the country concerned for use in reactors or research, the object being to prevent the stockpiling of plutonium. The International Plutonium Storage System (IPS) has been studied by an IAEA expert group since 1978; if it is put into effect it will probably be an integral part of the Agency's safeguards system.

A similar study group is looking into questions of international or multinational arrangements for the storage of spent fuel.

In June 1980, after the conclusion of INFCE, the Board of Governors established a Committee on Assurances of Supply (CAS), open to Member States of the Agency, with a view to restoring the stability of the international nuclear supply system under an acceptable non-proliferation regime. The establishment of this Committee reflects the extent to which the questions of nuclear supplies and safeguards have become intimately linked with each other and the fact that today there could be no significant nuclear trade except within the framework of an effective safeguards regime.

The present position

The spread of nuclear technology

By the end of 1980 a total of 253 nuclear power reactors were in operation in 22 countries, providing about 8% of the world's electricity. By 1985, power reactors already under construction will raise this figure to about 17%. In addition, 353 research reactors are in operation or under construction in 49 countries. The spread of nuclear energy has thus been impressive despite a number of setbacks during the last decade (see Figs 1a and 1b).

At the same time the overt spread of nuclear weapons has slowed down. During the decade that began with Hiroshima (1945 – 1954) three nations became nuclear-weapon States; during the next decade (1955 – 1964) two more followed. During the third decade ending in 1974 only one additional nation exploded a nuclear device, as Fig. 1b shows. In other words, the spread of nuclear weapons

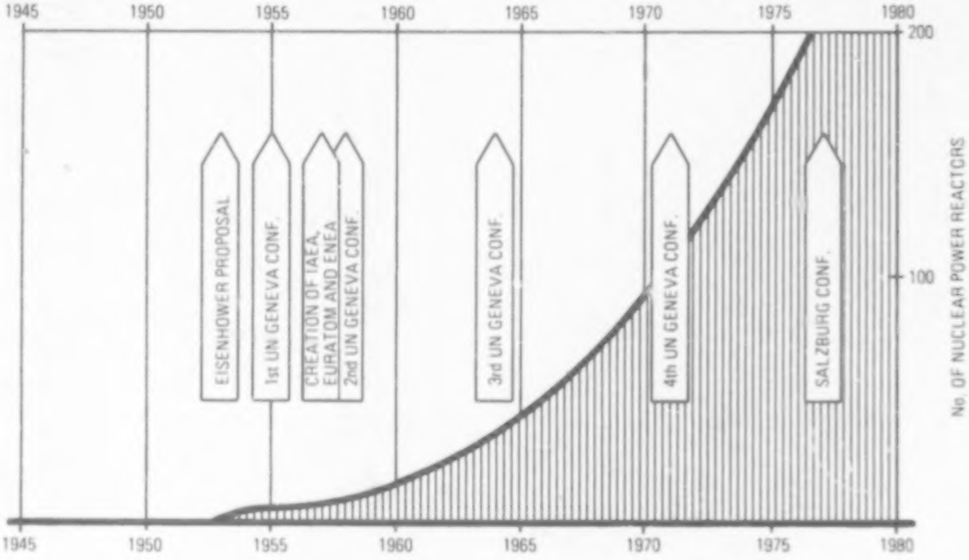

FIG. 1a. Main international steps to promote the peaceful uses of nuclear energy and the growth of nuclear power.

Notes: *(1) The first UN Conference on the Peaceful Uses of Atomic Energy in Geneva in 1955 led to the first major declassification of secret nuclear information. The subsequent conferences continued this tradition, turning with time more to practical technology than to basic science.*

(2) The IAEA International Conference on Nuclear Power and Its Fuel Cycle in Salzburg in 1977 dealt with the overall role to be played by nuclear energy, making particular reference to the fuel cycle and the need for its integration on a national and international level.

(3) Euratom = European Atomic Energy Community. ENEA = European Nuclear Energy Agency: now entitled Nuclear Energy Agency (NEA) of the OECD.

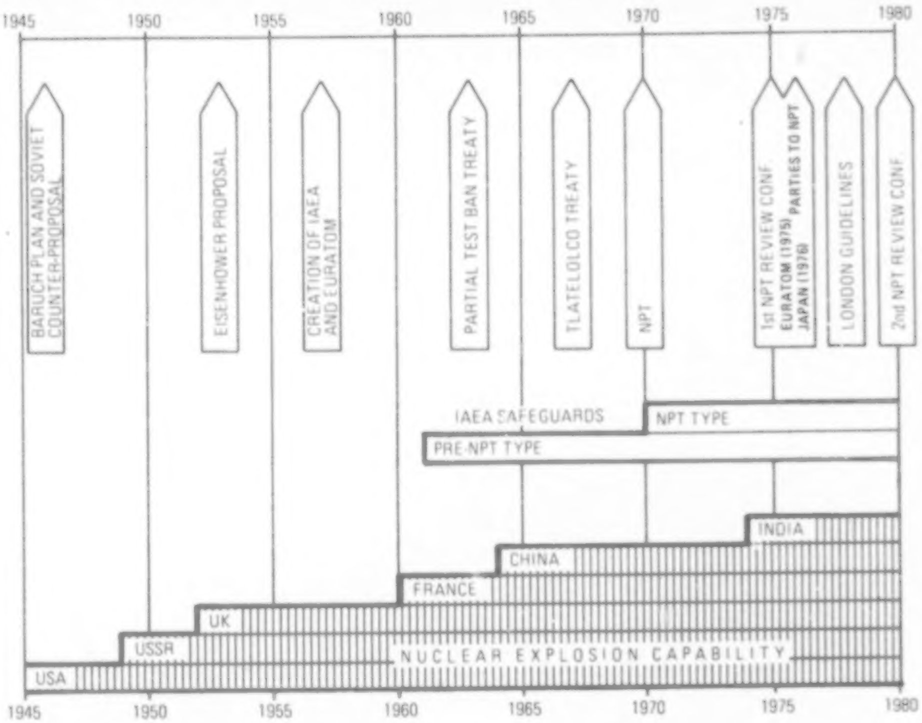

FIG.1b. Main international steps or proposals for stopping the spread of nuclear weapons.

Notes: *(1) The first IAEA Safeguards System (pre-NPT type) was adopted in 1961 to cover nuclear reactors with less than 100 megawatts thermal output. In 1964 this system was extended to cover all nuclear reactors. A second IAEA Safeguards System (also pre-NPT type), adopted in 1965, replaced the first and is still applied. It covers nuclear reactors and, by extensions in 1966 and 1968, also reprocessing, conversion and fuel fabrication plants.*

(2) In addition to the second IAEA Safeguards System there exist provisions (NPT type) for the application of safeguards to all peaceful nuclear activities in the non-nuclear-weapon States parties to the NPT.

and nuclear explosives has, at least so far, slowed down while knowledge of how to make them has become widespread.[3]

There are many reasons for this. It was for instance the Second World War that laid the basis for the US, USSR, UK and French nuclear weapons programmes and that led to the treaties and national laws which make it illegal for the Federal Republic of Germany and Japan as well as several other European countries to acquire nuclear weapons. Nevertheless it is reasonable to conclude that the political and institutional steps the world has taken to prevent proliferation – the creation of the IAEA, the formulation of the IAEA safeguards system, the NPT and the Tlatelolco Treaty[4] – have also played a useful part. They have provided the means for governments to ratify in a binding manner and for all the world to see their decisions to forgo nuclear weapons and also, by accepting IAEA safeguards, to show the world that they are carrying out their undertakings. This assurance to the international community has raised confidence, increased international security and lessened the incentive of other countries to acquire nuclear weapons.

The present safeguards situation

By December 1980 a total of 113 States, including three nuclear-weapon States (USSR, UK, USA), had become parties to the NPT.[5] The NPT covered almost all the non-nuclear-weapon States of the industrial world[6] as well as some 70 developing States (see Fig.2).

---

[3] Although certain processes in the nuclear fuel cycle (enrichment and reprocessing) can be used either for peaceful purposes or to make nuclear explosives, this short summary shows that the *expansion of nuclear power has not gone hand in hand with the spread of nuclear weapons.* Indeed, most of the five nuclear-weapon States tested their first bombs several years before the entry into service of their first power reactors; in one case (China) there is still no nuclear power plant in operation or even under construction.

[4] The conclusion of an effective 'comprehensive test ban treaty', prohibiting all tests of nuclear explosives, would clearly be a further major step in preventing the spread of nuclear weapons. The 1963 Moscow Partial Test-Ban Treaty prohibits such tests in the atmosphere, outer space and under water but does not proscribe underground tests provided that the resulting debris does not cross the frontiers of the testing State. Underground testing by the nuclear-weapon States continues at the rate of about 50 tests a year.

[5] Egypt became party to the NPT on 26 February 1981.

[6] The only industrial non-nuclear-weapon State which has not yet accepted the NPT is Spain, but in March 1981 that country concluded an agreement with the IAEA which had the effect of bringing all existing nuclear activities in Spain under the IAEA's safeguards. This agreement entered into force on 11 May 1981.

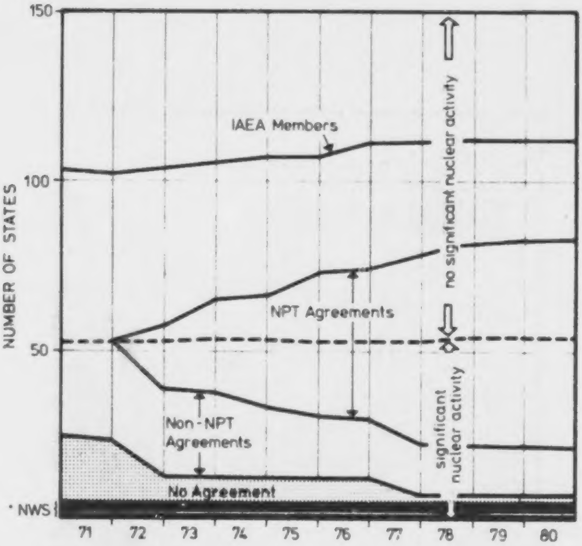

*FIG.2. Evolution of safeguards agreements 1970–1980. (***Note:*** Three of the five nuclear-weapon States (NWS) are parties to the NPT).*

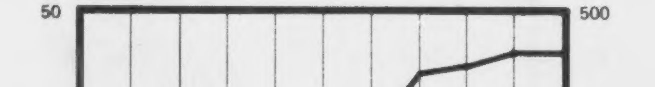

FIG.3. Number of States visited by IAEA inspectors and number of major nuclear installations under safeguards.

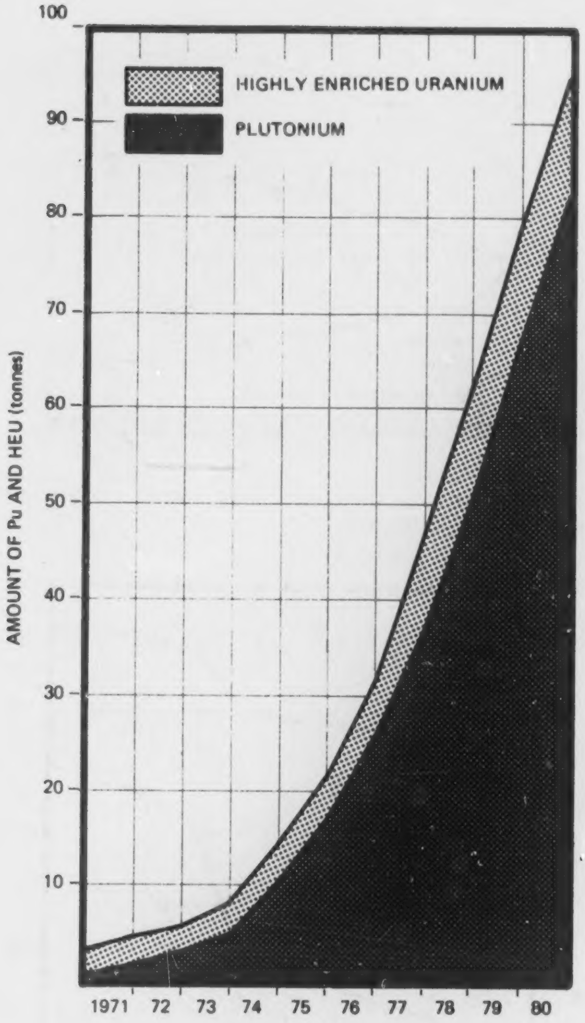

FIG.4. Amounts of plutonium and highly enriched uranium under safeguards.

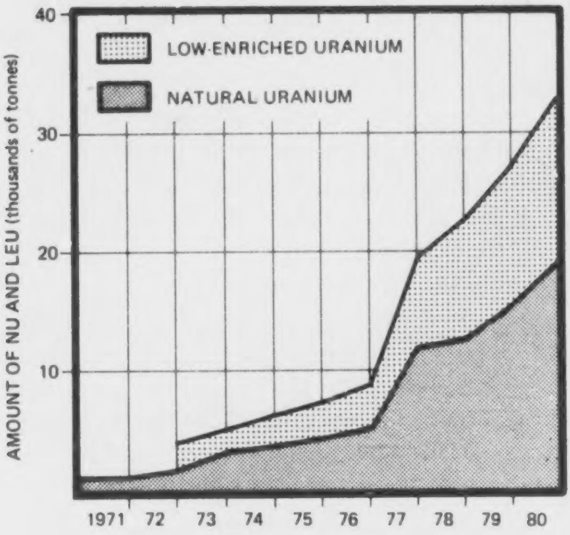

FIG.5. Amounts of natural uranium and low-enriched uranium under safeguards.

By the end of 1980 the IAEA was also applying safeguards in ten non-nuclear-weapon States which were not parties to the NPT, namely Argentina, Brazil, Chile, Colombia, the People's Democratic Republic of Korea, India, Israel, Pakistan, South Africa and Spain. In six of these countries all significant nuclear activities of which the IAEA was aware were covered by a series of individual safeguards agreements. In the remaining four (India, Israel, Pakistan and South Africa), unsafeguarded as well as safeguarded nuclear facilities were in operation or under construction and the unsafeguarded facilities were or will be capable of producing weapons-grade nuclear material.

With the four exceptions noted, almost the entire known nuclear industry outside the nuclear-weapon States is thus under the safeguards of the IAEA.[6] The growth which this has brought to the Agency's safeguards responsibilities is illustrated in Fig.3.

Figure 4 shows the growing amount of highly enriched uranium and of plutonium under IAEA safeguards. Most of the plutonium is in spent fuel from power reactors and would be usable for power production, or as an explosive, only after the fuel had been reprocessed. Figure 5 illustrates the increasing amount of low-enriched and natural uranium under safeguards.

THE OBJECTIVES OF SAFEGUARDS

The political objectives

Safeguards are essentially a technical means of verifying the fulfilment of political obligations undertaken by States in concluding international agreements relating to the peaceful uses of nuclear energy. Today most of these obligations flow from the NPT and similar agreements.

The main political objectives of safeguards are:

To assure the international community that States are complying with their non-proliferation and other 'peaceful use' undertakings;

To deter (a) the diversion of safeguarded nuclear materials to the production of nuclear explosives or for other military purposes and (b) the misuse of safeguarded facilities with the aim of producing unsafeguarded nuclear material.

The assurance given by safeguards

States conclude safeguards agreements voluntarily and the IAEA has no authority to apply safeguards unless the State concerned so requests (as it is obliged to do if it is a party to such legal instruments as the NPT). In view of the voluntary nature of this acceptance of safeguards, and for other reasons, it is reasonable to expect that the normal results of applying safeguards will be to confirm that there has in fact not been any diversion. Confirmation that this is so results from independent verification by the IAEA inspectorate. The assurance thus obtained from the IAEA's activities as an independent and objective auditor increases confidence between States and helps to diminish political insecurity which is normally the main motivation for acquiring nuclear weapons.

The deterrent effect

Deterrence is aimed at dissuading any State that might contemplate diversion of nuclear materials or the misuse of nuclear facilities. It follows that, to constitute an effective deterrent, safeguards must be technically capable (and be *seen* to be capable) of promptly detecting the diversion. Detection of diversion must also be seen to entail effective penalties for the diverting country.

Penalties or sanctions

The IAEA Statute and safeguards agreements specify a number of formal sanctions against the breach of a safeguards agreement. They consist chiefly of an alert to the international community (the UN Security Council, the UN General Assembly, all IAEA members), curtailment of IAEA assistance, and suspension of the privileges and rights of IAEA membership.

The effectiveness of these formal sanctions, should it be necessary to evoke them, will depend upon the actions taken by governments in response to the alert given by the Agency. In other words, for safeguards to be an effective deterrent it must be perceived that the international community will respond promptly and vigorously if the IAEA should ever have to 'sound the alarm'.

The extent to which the risk of detection and its consequent penalties would in practice be an effective deterrent will also obviously vary between States and according to political circumstances.

The technical instrument

The technical instrument for achieving the political objectives defined above is the safeguards arm of the IAEA, particularly the Safeguards Department. This is designed to provide continuing assurance to the international community that any diversion would be promptly detected. At least equally important is that it should also provide assurance that if, as has up to now always been the case, no diversion has occurred, the IAEA will be able to verify the correctness of the statements it has received from the State concerning its safeguarded nuclear material and facilities. The political value as well as the effectiveness of the IAEA's safeguards work thus depends significantly on the way in which its detection capability is perceived by those States which expect the IAEA to provide assurance as well as by any State which might contemplate diversion and wished to know how much risk there is of being detected.

Limits to the system

It should be clear that no international safeguards system can physically prevent diversion. The IAEA could not of course prevent any NPT party from exercising its legal right to withdraw from the NPT[7] nor could it prevent countries that have not accepted NPT or similar obligations from building unsafeguarded facilities.[8] Unfortunate as this may be, the IAEA's system can do no more than detect diversion of safeguarded material or misuse of safeguarded plant, and trigger international action. This can, however, be seen as progress since the acceptance of safeguards always involves for the State concerned giving up a measure of national sovereignty.

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[7] For many reasons, withdrawal from the NPT is nevertheless very unlikely. There is no provision for withdrawal from the Tlatelolco Treaty but States may under certain circumstances cease to be bound by certain crucial articles.

[8] Hence there can be no question of the IAEA 'imposing' its safeguards on a reluctant State. The question is sometimes asked: Why doesn't the IAEA step in and place a particular facility under its safeguards? Such action is neither politically nor legally feasible.

Safeguards and physical protection

The protection of nuclear materials and facilities against forcible seizure, theft, terrorism and other criminal activities is the responsibility of the State.[9] This is not the objective of international safeguards, which are directed against the risks of proliferation (or other proscribed activities) *by States.* It follows that the authority and measures required for each of these two activities are different, so too are their objectives and the criteria they apply.

Thus, at the international level the Agency's rights are limited to those which are accorded by the agreement with the State concerned.

A State, on the other hand, is able to use all the power and authority at its disposal, including police and military force, to physically protect nuclear facilities and material and to recover any material which may have been illegally diverted. Similarly, whereas the State may apply the full force of the law to ensure compliance with its legal requirements, the actions that the IAEA may take are explicitly limited by the relevant safeguards agreements and its statute.

The technical objective

The technical objective of safeguards in agreements concluded under the NPT is defined as "the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown and deterrence of such diversion by risk of early detection". In safeguards agreements concluded under the non-NPT system (INFCIRC/66 Rev.2) there is no specific definition of technical objectives but in practice today essentially the same concepts apply.

This definition contains two expressions requiring quantification: 'significant quantities' of nuclear material and 'timely detection' of diversion.

It is again important to keep in mind the difference in the content of these terms when they are used in relation to national measures of physical protection and when used with international safeguards.

A national physical protection system may have to be designed to detect unlawful action within hours or even minutes. Moreover the unlawful removal or other misuse of only a few grams of plutonium could be significant because of the health hazard it may pose.

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[9] In some countries *physical* protection measures are also referred to as safeguards.

Since the objective of an international safeguards system is essentially to deter governments from making nuclear weapons or other nuclear explosives, the detection within hours or even minutes of such small amounts as a few grams is not necessary and cannot reasonably be required. For international safeguards the significant quantity is the approximate quantity of nuclear material which could possibly be used to manufacture a nuclear explosive device. It is of the order of magnitude of 8 kilograms of plutonium or 25 kilograms of highly enriched uranium.

Similarly, in the context of international safeguards 'timely detection' can be related to the time required to convert diverted material into the components of a nuclear explosive device (namely, conversion time).

Results so far

As has been said, safeguards can exercise their deterrent effect only if they are seen to be capable of early detection of a diversion. IAEA safeguards have been applied since the 1960s. No diversion of any safeguarded item has been recorded, and while the possibility of a future diversion of safeguarded material or misuse of plants cannot be excluded its likelihood will generally remain small, partly because of the operation of the system itself. While the effectiveness of a national police force can be measured in terms of its success rate against crime, that of international safeguards cannot be demonstrated by statistics showing for instance the proportion of diversions detected in relation to the total number of diversions. Other means must be used in order to give an assurance of this kind to the Agency's Member States that the IAEA safeguards system is effective.

Thus, for instance, governments are informed not only of the conclusions the IAEA reaches in implementing safeguards but also of the rationale and methods used to reach these conclusions, the approaches and procedures followed in applying safeguards and the factual material on which the conclusions are based.

To give an example: in 1980 about six million 'surveillance' pictures were taken in nuclear facilities and evaluated by the IAEA, 6000 seals were issued, and 3000 were returned for verification. IAEA inspectors and safeguarded States submitted reports on about 700 nuclear installations, and about 400 000 data entries were made in the Agency's computer. The effectiveness of inspection and evaluation activities in disclosing departures from the norm is shown by the fact that in 1980 about 200 discrepancies and anomalies were detected. Most of them were minor and in all cases they were satisfactorily explained upon subsequent appraisal and investigation. It was thus again reasonable to conclude that nuclear material under IAEA safeguards in 1980 – as in previous years – had remained in peaceful nuclear activities or had otherwise been adequately accounted for.

SAFEGUARDS APPROACHES AND IMPLEMENTATION

The State's system of accounting for and control of nuclear materials (SSAC)

Safeguards agreements concluded pursuant to the NPT require the State to establish and maintain a national system of accounting for and control of nuclear material within its territory, jurisdiction or control (in the case of the European community the safeguards system of Euratom fulfils this function). In fact, most States having a significant nuclear programme, whether or not they are parties to NPT safeguards agreements with the IAEA, find it to be in their national interest to establish effective means of accounting for and control of nuclear materials in their territories.

The safeguards measures applied by the IAEA will now be described in more detail. In NPT States (and increasingly in others as well), the IAEA nuclear materials accountancy and verification are based on *reports* submitted by the SSAC as well as on *records* kept at facilities. It is the responsibility of the competent national authority to ensure that plant operators comply with the requirements of the safeguards agreement. These requirements include proper and accurate keeping of records and timely and accurate reporting according to an agreed format. The national authority must also ensure that the capabilities and equipment at nuclear factilities for measuring the quantity and composition of nuclear material are maintained at the level of the latest international or comparable standards. The national authorities are also responsible for ensuring that IAEA inspectors are granted all necessary access to facilities and material and for providing the support they require effectively to discharge their duties. They must also enable and assist IAEA inspectors to apply containment and surveillance measures (e.g. seals, cameras, and other recording devices) at nuclear facilities. In some cases the same measure or device is used to meet the requirements of both domestic physical protection measures and IAEA safeguards.

Design of the safeguards approach

The material for nuclear explosives, whether highly enriched uranium (HEU) or plutonium (Pu), is produced in specialized facilities. The construction and misuse of commercial nuclear power reactors is not the easiest nor the most efficient route to acquiring nuclear material for the manufacture of nuclear explosives. However, fuel cycle facilities associated with such reactors might be used in some circumstances to produce unsafeguarded nuclear material for nuclear explosives. It is, therefore, necessary for *all* nuclear material in a country's fuel cycle to be safeguarded if the IAEA is to be in a position to give assurances of non-diversion for the State as a whole.

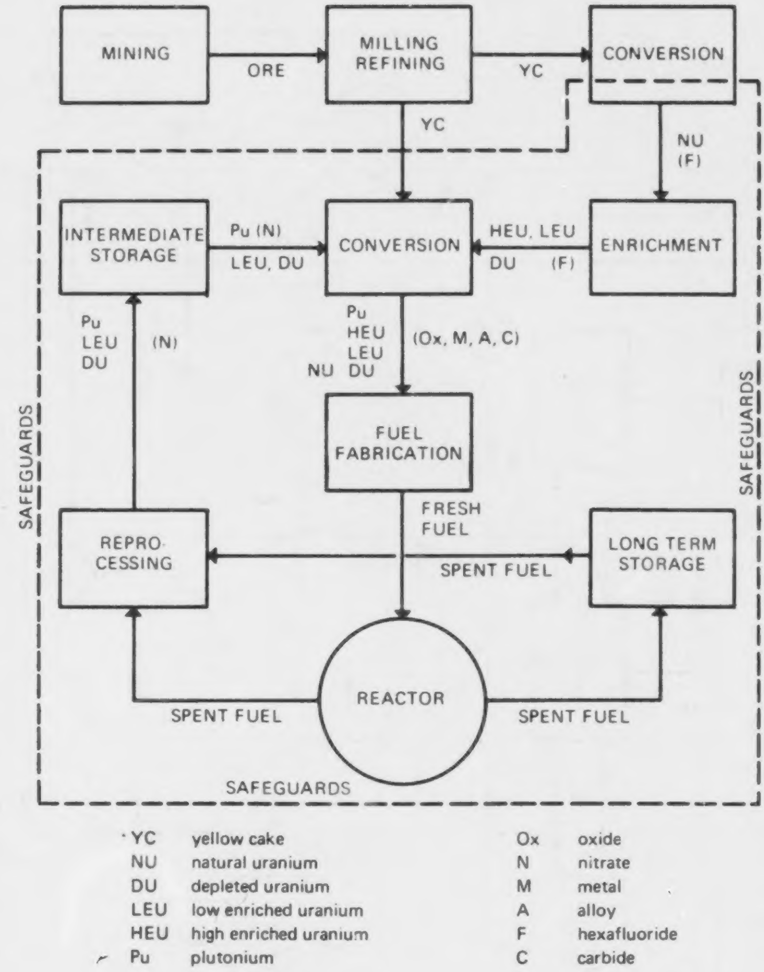
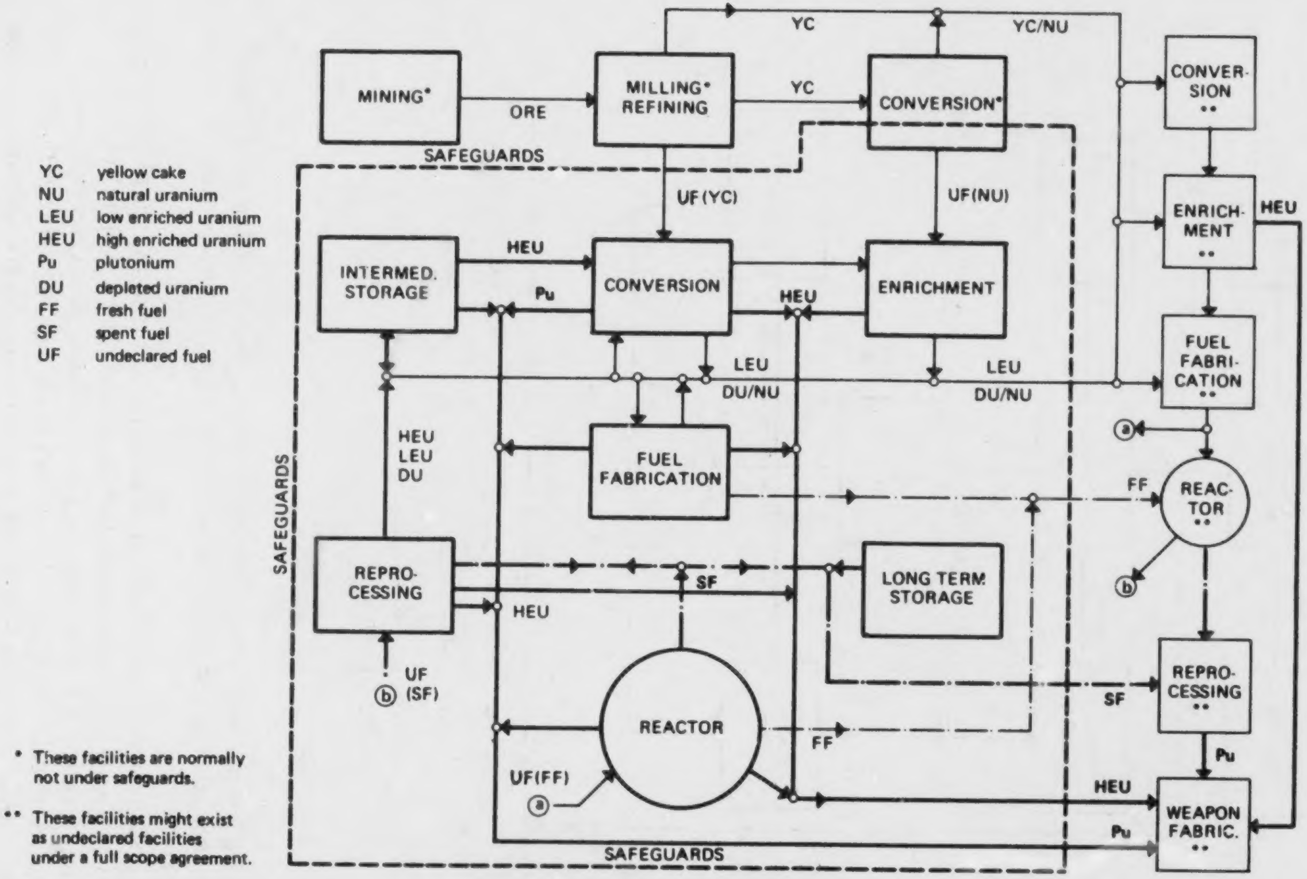

MINING
ORE
MILLING REFINING
YC
CONVERSION
YC
NU (F)
INTERMEDIATE STORAGE
Pu (N)
LEU, DU
CONVERSION
HEU, LEU
DU (F)
ENRICHMENT
Pu
LEU
DU
(N)
Pu
HEU
LEU
NU DU
(Ox, M, A, C)
FUEL FABRICATION
SAFEGUARDS
SAFEGUARDS
FRESH FUEL
REPRO-CESSING
SPENT FUEL
LONG TERM STORAGE
REACTOR
SPENT FUEL
SPENT FUEL
SAFEGUARDS
YC yellow cake
NU natural uranium
DU depleted uranium
LEU low enriched uranium
HEU high enriched uranium
Pu plutonium
Ox oxide
N nitrate
M metal
A alloy
F hexafluoride
C carbide

FIG.6. Simplified flow diagram of the nuclear fuel cycle.

The term 'nuclear fuel cycle' refers to the system of nuclear installations interconnected by a stream of nuclear material used in the production of nuclear energy.

Such a system may consist of uranium mines, ore-processing plants, conversion plants, enrichment plants, fuel fabrication plants, reactors (where the energy is extracted), spent fuel storages, reprocessing plants and associated storage. The fuel cycle can be 'closed' in various ways, e.g. by recycling of plutonium and uranium through reactors, by re-enriching the uranium recovered as a result of reprocessing, or by using the plutonium in the fast breeder reactor fuel cycle. All these stages taken together are illustrated schematically in Fig.6.


YC yellow cake
NU natural uranium
LEU low enriched uranium
HEU high enriched uranium
Pu plutonium
DU depleted uranium
FF fresh fuel
SF spent fuel
UF undeclared fuel
MINING*
ORE
MILLING* REFINING
YC
CONVERSION*
YC
YC/NU
CONVERSION ••
ENRICH-MENT ••
HEU
SAFEGUARDS
UF (YC)
UF(NU)
INTERMED. STORAGE
HEU
Pu
CONVERSION
HEU
ENRICHMENT
LEU
DU/NU
LEU
DU/NU
FUEL FABRI-CATION ••
ⓐ
HEU
LEU
DU
FUEL FABRICATION
FF
REAC-TOR ••
ⓑ
REPRO-CESSING
SF
HEU
LONG TERM STORAGE
UF
ⓑ (SF)
REACTOR
FF
SF
REPRO-CESSING ••
Pu
UF(FF)
ⓐ
HEU
Pu
WEAPON FABRIC. ••
SAFEGUARDS

* These facilities are normally not under safeguards.

** These facilities might exist as undeclared facilities under a full scope agreement.

FIG. 7. Simplified flow diagram of proliferation paths.

Of course, only a few countries have facilities corresponding to all the installations shown in the figure. In most countries only part of the fuel cycle exists – in the minimum case only a power reactor supplied from abroad, or an R & D laboratory.[10]

An important step in the analytical process leading to adoption of a specific safeguards approach is a careful analysis of hypothetical 'diversion strategies' that could be used by a diverter. Figure 7, in contrast to Fig.6, does not show the legitimate paths normally followed by nuclear material in a commercial fuel cycle, but surveys the diversion paths along which nuclear material could be diverted. The possibility of unsafeguarded facilities[11] must be assumed in any safeguards study and this is also reflected in Fig.7, which shows the confusing variety of 'diversion paths' for different kinds of nuclear material that have to be analysed. This diagrammatical representation must of course be extended or simplified in each individual case to reflect the actual fuel cycle of the country concerned. The set of diversion paths which is assumed to be part of plausible diversion strategies forms the 'diversion assumption' and is taken into account in designing, implementing and evaluating safeguards in a given situation.

Safeguards practices can be summarized in one word: verification. To verify means 'to establish the truth of'. In safeguards, to verify is to establish the truth of statements regarding the amounts, presence and use of nuclear material or other items subject to safeguards as recorded by facility operators and as reported by the State to the IAEA. Accountancy, taken together with containment and surveillance, is the fundamental basis on which verification rests.

The verification process can be described as consisting of three distinct stages:

(1) The *examination* of the information provided by the *State* in:
  - Design information describing installations under safeguards
  - Accounting reports listing, inter alia, nuclear material inventories, receipts and shipments
  - Documents amplifying and clarifying reports
  - Advance notification of international transfers.

(2) The *collection* of information by the *IAEA* as a result of:
  - Inspections for the verification of the design information
  - Inspections to examine records and reports and inspection of nuclear material
  - Special inspections in case of unusual findings.

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[10] A more detailed description of the fuel cycle facilities can be found in the IAEA publication 'IAEA Safeguards: Glossary' (IAEA/SG/INF/1, published 1980).

[11] The existence of such facilities may or may not be acknowledged. In the case of NPT States such facilities would of necessity be 'undeclared', i.e. clandestine.

(3) The *evaluation* of the information provided by the State and of that collected by inspectors, to determine the completeness, accuracy and validity of the information provided by the State.

Statements are provided by the IAEA to States, recording the results of safeguards activities in the State concerned. Mechanisms are in existence for the resolution of anomalies and discrepancies which may be detected by the IAEA.

Nuclear materials accountancy [12, 13]

It is the purpose of nuclear materials accounting[13] to establish the quantities of nuclear material present within defined areas and the changes in these quantities that take place within defined periods of time. The essential elements of such accounting are:

The operator identifies and counts or measures the material in the area concerned

The operator keeps records of all transactions involving this material

The operator prepares accounting reports on these transactions and submits these reports via the State to the IAEA

The IAEA verifies and analyses the data in these reports to determine their correctness and to assess the amount of any material unaccounted for and evaluate the causes of any such material unaccounted for.

To make these tasks more manageable, material balance areas (MBAs) are established in nuclear installations. These MBAs are areas into and out of which all transfers can be determined and in which physical inventories can be taken to establish a nuclear material balance. The MBAs are agreed between States and the IAEA and are recorded in Subsidiary Arrangements to the Safeguards Agreements which regulate in detail the implementation of safeguards agreements. Within MBAs measurements are made at key measurement points (KMPs), which are locations where nuclear material may be measured for the determination of flow or inventory.

Accountancy in IAEA terms begins in practice with the determination by the operator of the *initial physical inventory* (stock-taking) for a facility or MBA and the recording of that inventory in a book in which the operator thereafter

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[12] The explanations in this sub-section apply to the majority of Agency safeguards agreements, which are concluded in accordance with the NPT, and to some extent with other agreements as well.

[13] In safeguards a certain distinction is made in the meaning of the words accountancy and accounting (see the definitions in 'IAEA Safeguards: Glossary' (IAEA/SG/INF/1, p.28).

records subsequent *inventory changes*. The results of periodical *physical inventory takings* by the operator and their relation to corresponding book inventories are fundamental to nuclear material accountancy. Any difference between the book inventory and the physical inventory is called 'material unaccounted for', abbreviated to MUF. The reasons for MUF may be found in measurement uncertainties or other technical causes. If the size of the MUF is found to be beyond a value attributable to such identifiable causes, the possibility that a diversion has been made must be considered.

Figure 8 is a highly simplified view of the application of accountancy procedures. When closing the books in respect of a material balance period (e.g. the calendar year n–1) in an MBA, the operator takes a physical inventory (PI) at the prescribed KMPs of all nuclear material present in the MBA, by counting, identifying, weighing, etc. The resulting figures for this 'beginning inventory' (PB_n) are at the same time the ending physical inventory (PE_{n-1}) for the previous material balance period, and the beginning book inventory for the next material balance period (see top block in Fig.8). The operator reports the results to the responsible State Office in the form of a physical inventory listing (PIL) and a material balance report (MBR) for the material balance period which closed. These reports are then transmitted to the IAEA. At the same time as the physical inventory takes place, or shortly thereafter, an IAEA inspection of the facility takes place for the purpose of verifying the physical inventory taking by making independent measurements, taking samples, etc. The results of this inspection and of the analysis of any samples are evaluated and the conclusions reached by the IAEA are transmitted to the State in the form of a statement (ST).

We now turn to the middle block in Fig.8. Any changes in the balance of nuclear material (e.g. receipts (R), shipments (S) or discards) are entered by the operator in his records and up-date his book inventory (BI). The changes are also reported through the State Office to the IAEA in the form of inventory change reports (ICRs). Routine IAEA inspections may be carried out to verify these changes, and the records are examined and compared with the reports sent to the IAEA. The results of these inspections are evaluated and the conclusions reached are communicated to the State.

The material balance period is closed by activities schematically represented in the last block in Fig.8. After verification of the ending physical inventory (PE_n) the difference (MUF) between the book inventory (BE_n) and the physical inventory (PE_n) is determined and evaluated and a statement is formulated. Once each year the IAEA submits a safeguards implementation report (SIR) to the Board of Governors. The SIR contains an overall assessment of safeguards effectiveness during the previous year and an analysis of the effectiveness and efficiency of safeguards implementation.

In his independent verification activities the inspector uses several methods which have been mentioned already in general terms. Figure 9 shows a simplified description of such methods used, inter alia, in a nuclear power reactor. A power

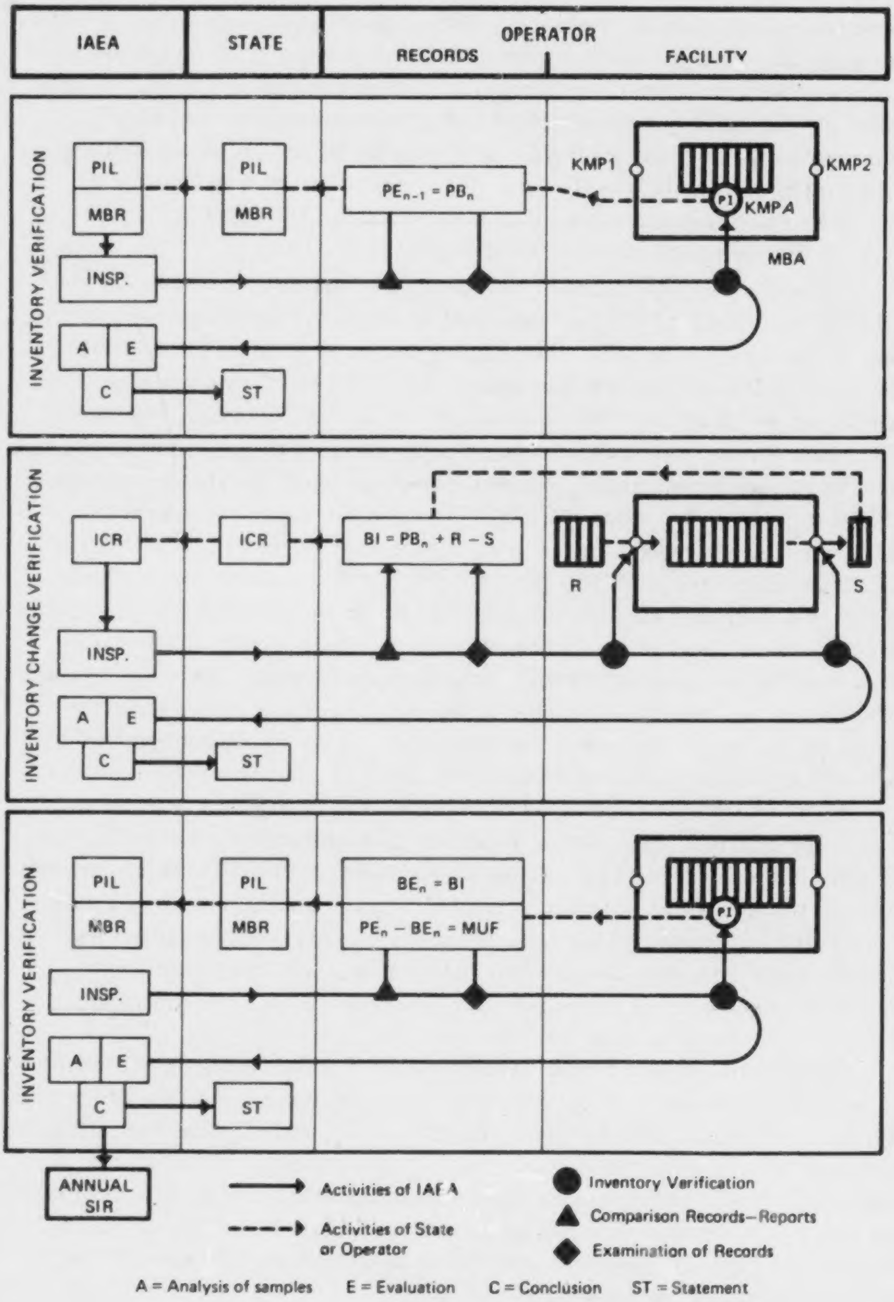

IAEA
STATE
OPERATOR
RECORDS
FACILITY
INVENTORY VERIFICATION
PIL
MBR
PIL
MBR
PE$_{n-1}$ = PB$_n$
KMP1
KMP2
PI
KMP*A*
MBA
INSP.
A
E
C
ST
INVENTORY CHANGE VERIFICATION
ICR
ICR
BI = PB$_n$ + R – S
R
S
INSP.
A
E
C
ST
INVENTORY VERIFICATION
PIL
MBR
PIL
MBR
BE$_n$ = BI
PE$_n$ – BE$_n$ = MUF
PI
INSP.
A
E
C
ST
ANNUAL SIR
Activities of IAEA
Activities of State or Operator
Inventory Verification
Comparison Records–Reports
Examination of Records
A = Analysis of samples
E = Evaluation
C = Conclusion
ST = Statement

FIG.8. Simplified scheme of nuclear material accountancy (explanation in the text). A – Analysis of samples. E – Evaluation. C – Conclusion. ST – Statement.

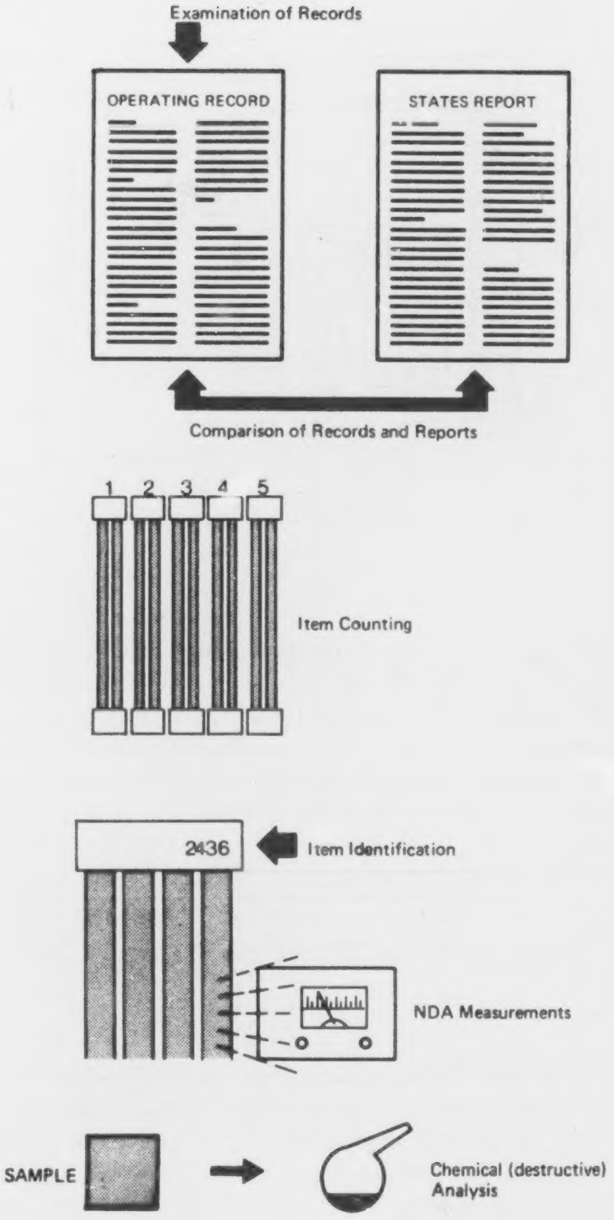

Examination of Records
OPERATING RECORD
STATES REPORT
Comparison of Records and Reports
1
2
3
4
5
Item Counting
2436
Item Identification
NDA Measurements
SAMPLE
Chemical (destructive) Analysis

FIG.9. Verification activities of inspectors or of the Safeguards Analytical Laboratory. (NDA = non-destructive assay).

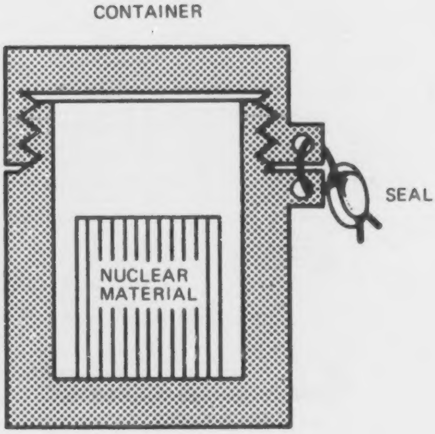


FIG.10. Containment measures: application of seal.

reactor is an 'item facility', i.e. the nuclear fuel is contained in identifiable items (fuel assemblies), the integrity of which is usually preserved during their presence in the plant. Such items can be followed through a considerable part of the whole fuel cycle, from the fuel fabrication plant, through the reactor, to the reprocessing plant or long-term storage. This facilitates the task of safeguards. Inspectors count the fuel assemblies, identify them by serial number or seals, and check on a statistical basis the fuel composition by non-destructive measurements. In 'bulk handling facilities', e.g. fuel fabrication plants, samples (pellets, powder, solutions) are taken and destructively analysed in the Agency's Safeguards Analytical Laboratory, by chemical or physical methods.

Containment and surveillance

Containment and surveillance measures take advantage of physical barriers such as walls, containers, tanks or pipes, to restrict or control the movement of or access to nuclear material. Such measures help to reduce the probability that undetected movements of nuclear material or equipment can take place. Containment/surveillance measures may involve the application of devices such as uniquely identified tamper-indicating seals to ensure that any change in the sealed inventory will be detected.

Surveillance means both human and instrumental observation in order to detect undeclared movements of nuclear material, tampering with containment, fabrication of false information or tampering with safeguards devices. Surveillance

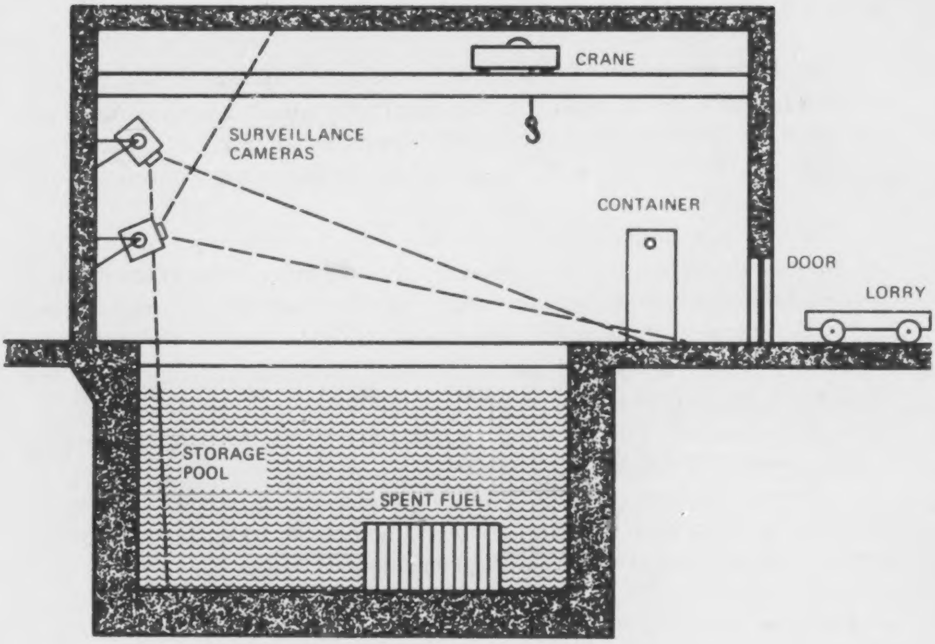


FIG.11. Combined application of containment and surveillance.

may involve the use of tamper-resistant automatic cameras or other devices to monitor changes in containment or to observe inventory changes. Personnel may carry out the same tasks by manning key observation points continuously or periodically.

For example, if a physical inventory of fresh fuel or of a new core loading in a reactor has been taken and it is possible to seal the fuel container (Fig.10) or reactor vessel, it is sufficient to verify periodically that the seal has not been tampered with in order to conclude that the inventory has not changed since the time when the seal was applied or last verified.

In the spent fuel storage, inspectors may make use of a combination of available containment/surveillance measures as shown in Fig.11. In this case, containment is provided by the walls of the building while surveillance is carried out by twin cameras which, during the absence of inspectors, take pictures at intervals shorter than the time needed to remove any fuel. Periodic evaluation of the films would thus reveal any removal of spent fuel.

The IAEA containment/surveillance measures are designed in such a way as to minimize intrusion in the work of a nuclear facility operator.

Inspections

Inspection is essential to implement the safeguards measures described above. Its aim is to verify the validity of information in the possession of the Agency. The maximum intensity and frequency of inspections are specified in the safeguards agreements and vary with the type of facility inspected. A proportion of routine inspections may be unannounced.

The NPT safeguards system distinguishes between three types of inspections.

Routine inspections are made to verify that the information contained in reports submitted by the State is consistent with the accounting and operating records kept by the operator. Routine inspections also verify the amount, the location and the identity of nuclear material, investigate shipper/receiver differences (in other words any differences in reports about the same item which may occur in notifications received from the shipper and the receiver of the item), uncertainties in book inventories, and MUF.

Ad-hoc inspections are made to verify information submitted by States regarding the design of new nuclear facilities, the first report made by the State after the conclusion of the safeguards agreement and changes between the submission of that first report and the beginning of routine inspections. Inspections made to verify material before it is sent abroad or after it is received from abroad are also classified as ad-hoc.

Special inspections are made in addition to routine inspections when unusual circumstances occur and are notified to the Agency in 'special reports', or in order to collect information in addition to that which the State routinely provides or which is obtained by routine inspections but is found to be inadequate. Special procedures must be followed for special inspections.

During inspections the IAEA's inspectors carry out numerous tasks; for instance they:

- Examine pertinent records
- Make independent measurements of safeguarded nuclear material (they may use the IAEA's own equipment or the State's or operators' equipment)
- Verify the proper functioning and calibration of equipment
- Obtain samples and ensure that they are properly collected, tested, handled and shipped
- Use and service IAEA surveillance equipment
- Affix, inspect and remove IAEA seals.

Verification is concentrated on the stages of the fuel cycle that involve the production, processing, use or storage of nuclear materials from which weapons could be readily made. The verification effort must however in all cases be sufficient to enable the IAEA to meet the defined objective of safeguards: the timely detection of the diversion of a significant quantity of nuclear material.

ORGANIZATION OF IAEA SAFEGUARDS

In discharging the safeguards responsibilities of the Secretariat, the Director General is supported by the Department of Safeguards and the Department of Administration. The former department deals with the implementation of safeguards and their development and evaluation; the latter provides assistance in the drafting and negotiating of safeguards agreements and in policy matters. The place of the Department of Safeguards in the framework of the Agency can be seen from Fig.12 and its internal structure from Fig.13.

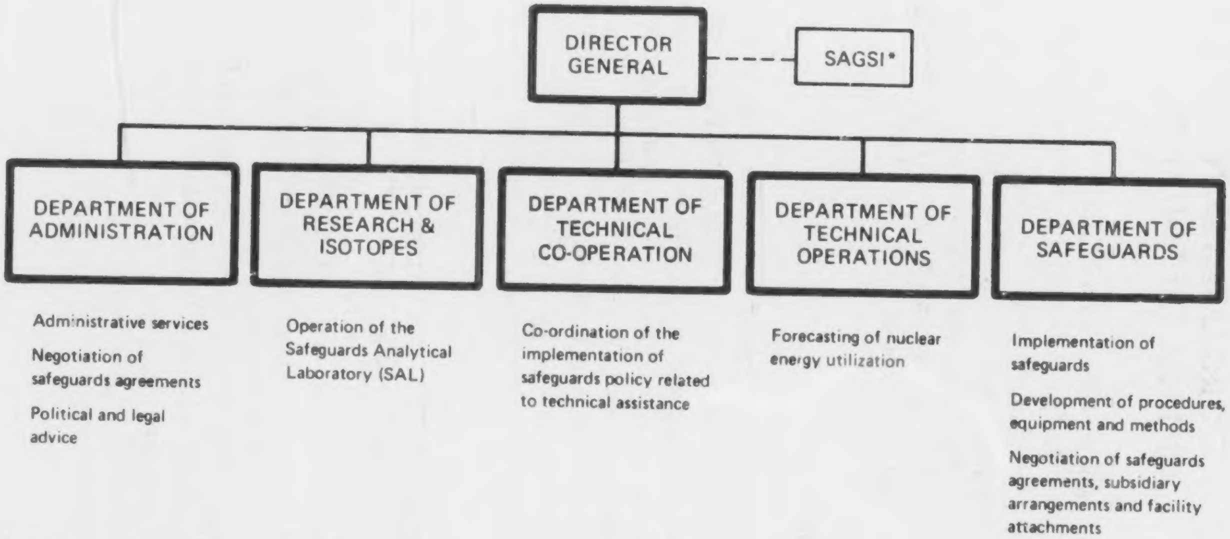
Safeguards operations

The implementation of safeguards agreements is entrusted to the two Divisions of Operations. Each consists of three Regional Sections and is manned by inspectors and supporting staff responsible for the direct application of safeguards. By the end of 1980 there were about 120 inspectors in these two divisions. Each division is responsible for planning inspection programmes and performing inspections. After returning from inspections, inspectors prepare inspection reports which include the data they have collected and the conclusions they have drawn. Inspectors are supported in their work by other units in the Department (e.g. data processing, analytical and evaluation services). The results of inspections and corresponding evaluations are condensed into statements which are sent to the respective States. The Divisions of Operations also up-date design information on facilities under safeguards and participate in the preparation and negotiation of Safeguards Agreements and Subsidiary Arrangements including Facility Attachments[14] needed to implement safeguards agreements. The divisions also do valuable work in summarizing their safeguards experience and participating in the development of new safeguards approaches.

The allocation of countries to the different Regional Sections has been decided upon taking into account the geographical location of each country and the inspection effort required for the facilities in it. The present organizational structure is as shown in Fig.13. The Regional Sections of the Division of Operations A implement safeguards in countries as follows:

---

[14] Subsidiary Arrangements describe interpretations of provisions in the Safeguards Agreement as accorded between the Agency and the State(s), and indicate in detail the manner in which the Agreement is to be implemented. Details of procedures applicable to all facilities in the State are included in the General Part of the Arrangements. Procedures relating to specific facilities are laid down in the Facility Attachments.


DIRECTOR GENERAL
SAGSI*
DEPARTMENT OF ADMINISTRATION
DEPARTMENT OF RESEARCH & ISOTOPES
DEPARTMENT OF TECHNICAL CO-OPERATION
DEPARTMENT OF TECHNICAL OPERATIONS
DEPARTMENT OF SAFEGUARDS
Administrative services
Negotiation of safeguards agreements
Political and legal advice
Operation of the Safeguards Analytical Laboratory (SAL)
Co-ordination of the implementation of safeguards policy related to technical assistance
Forecasting of nuclear energy utilization
Implementation of safeguards
Development of procedures, equipment and methods
Negotiation of safeguards agreements, subsidiary arrangements and facility attachments

* Standing Advisory Group on Safeguards Implementation

FIG.12. Organizational structure of the IAEA and the safeguards-oriented activities of its Departments.

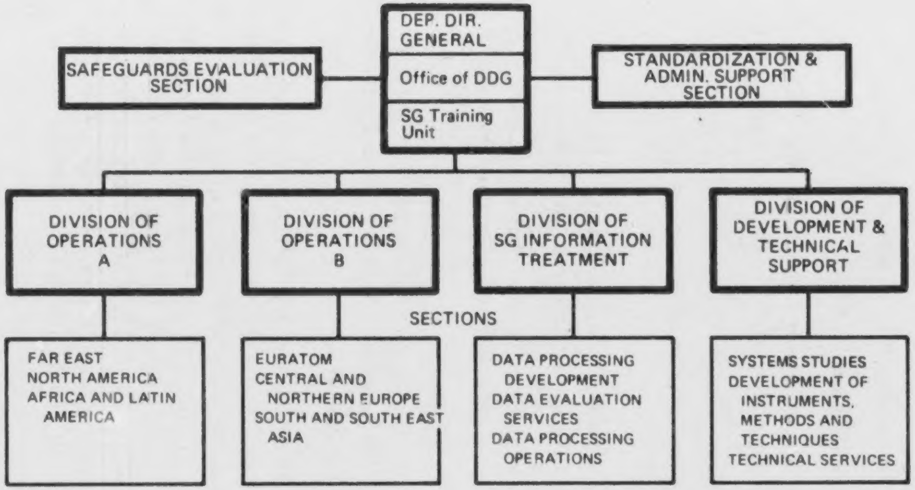

DEP. DIR. GENERAL
Office of DDG
SG Training Unit
SAFEGUARDS EVALUATION SECTION
STANDARDIZATION & ADMIN. SUPPORT SECTION
DIVISION OF OPERATIONS A
DIVISION OF OPERATIONS B
DIVISION OF SG INFORMATION TREATMENT
DIVISION OF DEVELOPMENT & TECHNICAL SUPPORT
SECTIONS
FAR EAST
NORTH AMERICA
AFRICA AND LATIN AMERICA
EURATOM
CENTRAL AND NORTHERN EUROPE
SOUTH AND SOUTH EAST ASIA
DATA PROCESSING DEVELOPMENT
DATA EVALUATION SERVICES
DATA PROCESSING OPERATIONS
SYSTEMS STUDIES
DEVELOPMENT OF INSTRUMENTS, METHODS AND TECHNIQUES
TECHNICAL SERVICES

FIG.13. Organizational structure of the Department of Safeguards.

Far East Section: Japan, Republic of Korea, Taiwan

North America Section: Canada, USA[15]

Africa and Latin America Section: Argentina, Brazil, Chile, Colombia, Libyan Arab Jamahiriya, Mexico, Peru, Portugal, South Africa, Spain, Uruguay, Venezuela, Zaire.

The Regional Sections of the Division of Operations B implement safeguards in countries as follows:

Euratom Section: Belgium, Denmark, France[16], Federal Republic of Germany, Ireland, Italy, Luxembourg, Netherlands, United Kingdom[16].

Central and Northern Europe Section: Austria, Bulgaria, Czechoslovakia, Finland, German Democratic Republic, Hungary, Norway, Poland, Romania, Sweden, Switzerland

South and South East Asia Section: Australia, Democratic People's Republic of Korea, Greece, India, Indonesia, Iran, Iraq, Israel, Pakistan, Philippines, Thailand, Turkey, Yugoslavia.

The workload of inspections and accordingly the manpower and financial requirements depend in the first instance on the number and type of installations under safeguards or containing safeguarded material. The growth of this number depends on the one hand on the development of nuclear energy throughout the world, on the other hand on the increase in numbers of safeguards agreements. Figure 14 shows the growth in the number of reactors under safeguards. The number of research reactors remained rather stable during the last decade and the increase shown in Fig.14 was mainly due to the increasing number of safeguards agreements. The growth curve of power reactors however reflects also a real increase of power reactors actually in operation. All nuclear power reactors in all non-nuclear-weapon States are now under safeguards (see Footnote 6).

---

[15] The agreement between the USA and the IAEA for the application of safeguards in the United States will be implemented in 1981. Under this agreement the USA permits the IAEA to apply its safeguards to all nuclear activities in the USA, "excluding only those with direct national security significance." The IAEA designates the facilities in which it will apply safeguards. Until now the IAEA has applied safeguards in the USA when so required by agreements with third countries, as well as in the USA or under special limited arrangements.

[16] The UK has similarly offered to accept safeguards on all facilities in the UK, "subject to exclusions for national security reasons only", and the relevant agreement entered into force in 1978. This agreement will likewise be implemented in 1981 at facilities designated by the IAEA. France has negotiated an agreement with the IAEA which will permit the IAEA to apply safeguards at facilities listed by France; this agreement entered into force on 12 September 1981. Until now, the IAEA has been applying safeguards in the UK and in France only in cases when so required by agreements involving third countries or under special arrangements.

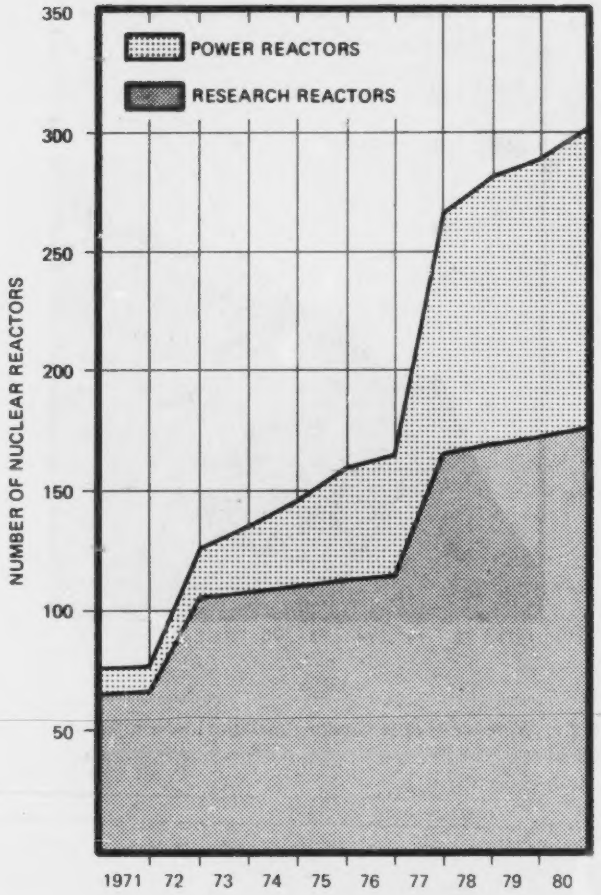


FIG.14. Number of nuclear reactors under safeguards.

As already mentioned, reactors are item facilities whose readily identifiable items (fuel assemblies) facilitate accounting for the contained nuclear material. The inspection effort needed to attain the safeguards objective depends on the type of reactor and lies between 1 and 50 man-days per year and reactor. For the light water reactors, which are by far the most common type of power reactor, about 10 – 15 inspector man-days per year are necessary.

Figure 15 shows the increase in the number of safeguarded bulk handling facilities in which nuclear material is handled in loose form (conversion plants, fuel fabrication plants, reprocessing plants, enrichment plants). Safeguarding such plants may require the presence of inspectors at frequencies ranging from 20 man-days per year up to continuous presence at the installation, depending on size and type of plant.

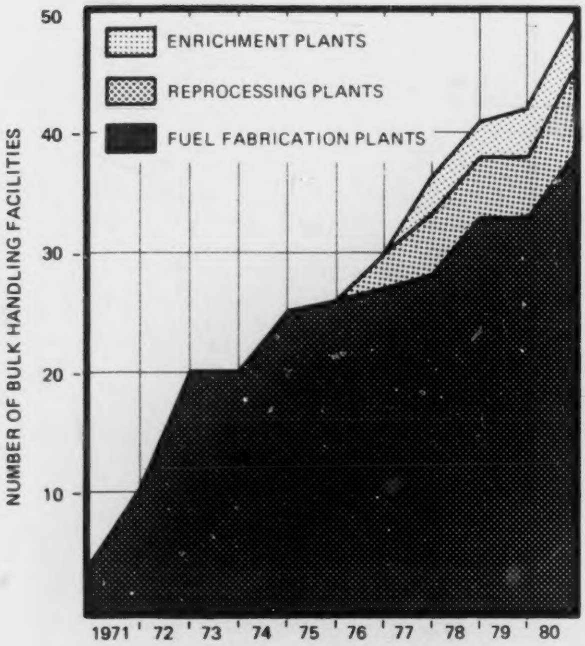


FIG.15. Number of bulk handling facilities under safeguards.

Besides the major types of facilities mentioned above several other installations like separate storage, other facilities and other locations outside facilities (for instance small research laboratories) have also been safeguarded (Fig.16).

The number of large installations under safeguards increased more than 4 times between 1970 and 1980 but, because of the growing unit size of installations and the increasing amount of spent fuel, the quantity of nuclear material under safeguards rose even more rapidly. During the same period the professional staff of the Department of Safeguards increased by a factor of only about 2.5. In 1980 about 1100 inspections were made at more than 500 facilities in 47 States.

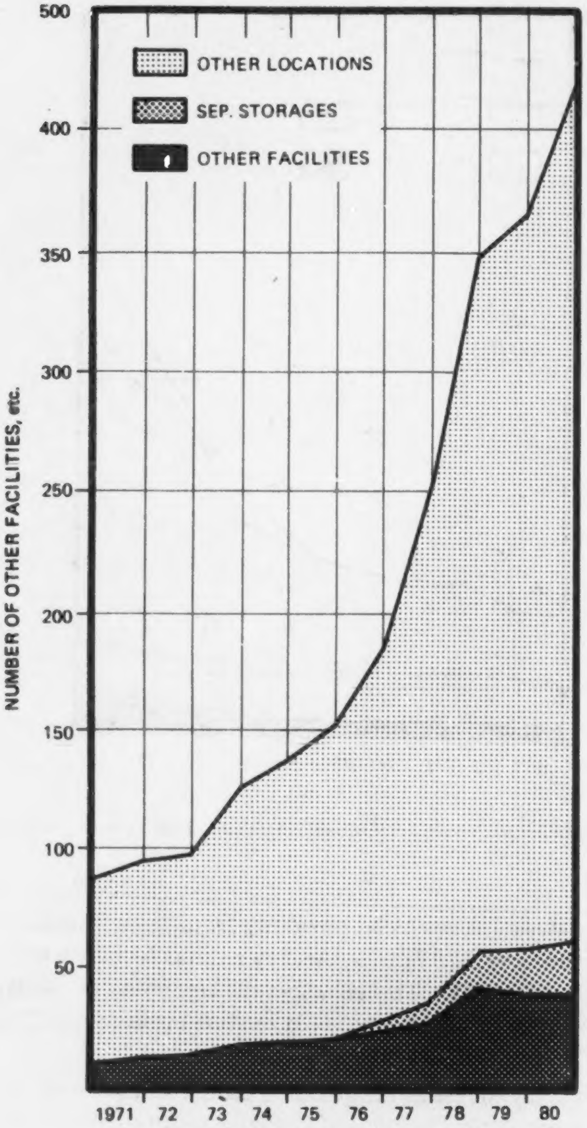


FIG.16. Number of separate storage facilities, other facilities and other locations under safeguards.

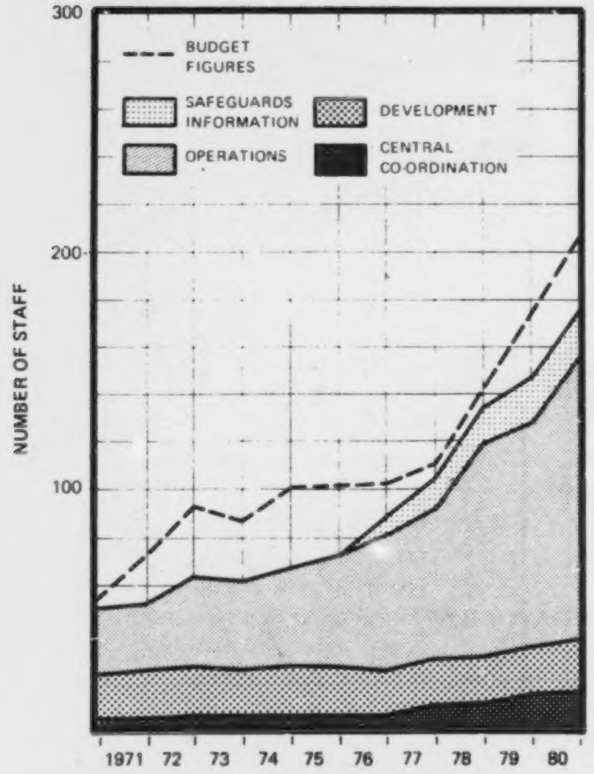


FIG.17. Increase in number of professional staff in the Department of Safeguards.

The growing safeguards workload obviously requires an increase in manpower of the IAEA inspectorate (Fig.17). The Agency recruits its personnel on as wide a geographical basis as possible. This enhances the credibility of the safeguards system in that it enables the Agency to avoid sending inspectors to their own country.

It is not always easy to recruit the qualified manpower, however. By the end of 1980 the inspectors of the Divisions of Operations came from 39 countries, including 26 developing countries.

Information treatment

Safeguards operations are supported by other organizational units, amongst them the Division of Safeguards Information Treatment (see Fig.13), handling the vast amount of safeguards information reported by States and collected by inspectors. The Division comprises three Sections.

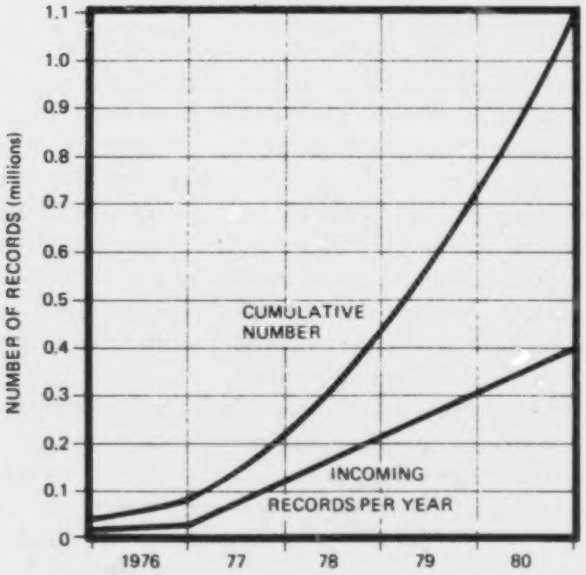


FIG.18. Increase in workload of the Division of Safeguards Information Treatment.

The *Data Processing Operations Section* is responsible for the computer processing of a variety of safeguards information including the accounting data furnished by Member States, inspection data and design data. The *Data Evaluation Services Section* provides assistance to inspectors in preparing inspections, evaluating their results, preparing inspection reports, evaluating data quality and trends, correlating data and analysing statistics. The *Data Processing Development Section* is responsible for the continuing development and evaluation of the computer techniques needed to satisfy the growing safeguards requirements.

The increasing number of records and reports which the Division of Safeguards Information Treatment processes and evaluates each year is shown in Fig.18. Several thousand questions are put to the system each year to satisfy the needs of the Divisions of Operations. Computer output data are also included in the annual Safeguards Implementation Report. Direct access to computerized data is permitted only to authorized safeguards personnel. This access is arranged by the use of computer terminals which provide immediate information on a 'need-to-know' basis. The arrangements for data stored in the computer are carefully designed to ensure their security. Established procedures are continually evaluated for their effectiveness.

Development and technical support

The Divisions of Operations require not only the support of an efficient computer unit; their activities in the field must be based on sophisticated safeguards strategies and techniques, their inspectors must be intensively trained, and they must be supplied with equipment of the highest possible standard. The resulting widely diversified tasks are assigned to the Division of Development and Technical Support (see Fig.13). There are three Sections in this Division.

The *Systems Studies Section* is the think tank of the Department. For each type of facility, plausible diversion strategies have to be postulated and safeguards approaches to defeat them have to be developed, together with methods for determining the effectiveness of the approaches.

Safeguards could not be efficiently and effectively implemented without large-scale use of all sorts of equipment and instrumentation for measurements, analyses and surveillance. This equipment must not only be accurate but also rugged, simple and portable. The main responsibility for developing, acquiring and testing the necessary equipment and instrumentation lies with the *Section for Development of Instruments, Methods and Techniques.* The IAEA does not have the financial resources to operate a special research and development laboratory and is therefore dependent on the support of Member States. At present three Member States[17] are funding research and development projects in safeguards problem areas suggested by the IAEA or in areas where existing equipment or instrumentation needs improvement or greater sophistication or flexibility. The Development Section defines the problems or specifications, co-ordinates the international efforts and performs acceptance tests.

The *Technical Services Section* is responsible for the provision of equipment, instruments and seals. This includes procurement, storage, calibration, maintenance, shipment and instruction on the use of instruments and in the application of techniques. Samples for analysis, taken by the inspector, are received by the Section and shipped for analysis to the Safeguards Analytical Laboratory, Seibersdorf, or a laboratory of the International Network of Analytical Laboratories. Seals are at present issued at the rate of 6000 a year. Optical surveillance devices such as film cameras are used in locations such as spent fuel storage ponds where sealing is impractical. More than one hundred twin-camera units are taking photos at a rate of over 20 000 per day.

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[17] Canada, Federal Republic of Germany, USA. Projects with Australia, Japan, USSR, UK and Euratom are under preparation.

Conclusion

The safeguards component in the Agency's budget increased from 10% in 1970 to 27% in 1980, reflecting the growth of the peaceful uses of nuclear energy and the increase in nuclear material and installations to be safeguarded. The major part of the budget is allocated to the promotional activities of the Agency. The cost of safeguards, which is at present borne largely by developed States, is appreciable, but in perspective it is not large – of the order of the cost of a single military aircraft per year. Divided by the energy produced by nuclear reactors annually throughout the world, it represents a cost of approximately US $0.00003 per kWh of electricity. Even if one applies a factor to this figure to include the safeguards expenses incurred by States and plant operators, the resulting cost is still minor compared with the benefits derived – a considerable contribution to international security.

Until now, safeguards have been invoked only to verify agreements dealing with nuclear energy. There is no technical reason, however, why the concept of safeguards should not extend to other international agreements dealing with potentially hazardous materials and equipment, for instance in the field of arms control and disarmament.

BIBLIOGRAPHY

The Agency's Statute	
The Non-Proliferation Treaty	IAEA Document INFCIRC/140
The Agency's Safeguards System (1965, as provisionally extended in 1966 and 1968)	IAEA Document INFCIRC/66/Rev.2
The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons	IAEA Document INFCIRC/153 (Corr.)
The Physical Protection of Nuclear Material	IAEA Document INFCIRC/225/Rev.1
Communications received from Members regarding the Export of Nuclear Material and of Certain Categories of Equipment and Other Material	IAEA Document INFCIRC/209

Communications Received from Certain Member States regarding Guidelines for the Export of Nuclear Material, Equipment or Technology	IAEA Document INFCIRC/254
IAEA Safeguards: Glossary	IAEA/SG/INF/1
IAEA Safeguards: Guidelines for States' Systems of Accounting for and Control of Nuclear Materials	IAEA/SG/INF/2

IAEA INTERNATIONAL SAFEGUARDS

AS OF 1 OCTOBER 1981

blue	Non-Nuclear-Weapon States Party to NPT with NPT Safeguards Agreements in Force.
green	Non-Nuclear-Weapon States Party to NPT for which NPT Safeguards Agreements Are Not Yet in Force.
red	Non-Nuclear-Weapon States not Party to NPT in which IAEA Safeguards Agreements Are in Force on All Operating and Planned Nuclear Activities.
white	Non-Nuclear-Weapon States not Party to NPT having No Significant Nuclear Activities.
yellow	Non-Nuclear-Weapon States not Party to NPT in which Certain Nuclear Activities are Not under IAEA Safeguards.
violet	Nuclear-Weapon States Party to NPT.
orange	Nuclear-Weapon States not Party to NPT.

■ All nuclear activities currently under IAEA safeguards (non-NPT).

▲ Small unsafeguarded research reactor.

The sole purpose of this map is to illustrate the scope of IAEA safeguards and it does not imply the expression of any opinion whatsoever on the part of the IAEA concerning the legal status of any country or territory or of its authorities, or concerning the delimitation of frontiers.

PACIFIC OCEAN
INDIAN OCEAN
ATLANTIC OCEAN
PACIFIC OCEAN
UNION OF SOVIET SOCIALIST REPUBLICS
MONGOLIA
INDIA
AUSTRALIA
NEW ZEALAND
PHILIPPINES
INDONESIA
MADAGASCAR
IRAN
TURKEY
EGYPT
SUDAN
ETHIOPIA
KENYA
ZAIRE
ANGOLA
SOUTH AFRICA
CHAD
NIGER
NIGERIA
MALI
ALGERIA
TUNISIA
LIBYAN ARAB JAMAHIRIYA
MAURITANIA
SENEGAL
FINLAND
POLAND
MALTA
ICELAND
GREENLAND (DEN.)
CANADA
UNITED STATES OF AMERICA
MEXICO
VENEZUELA
ECUADOR
PERU
BOLIVIA
PARAGUAY
URUGUAY

blue Non-Nuclear-Weapon States Party to NPT with NPT Safeguards Agreements in Force

- Afghanistan
- Australia
- Austria
- Belgium
- Bulgaria
- Canada
- Costa Rica
- Cyprus
- Czechoslovakia
- Denmark
- Dominican Republic
- Ecuador
- El Salvador
- Ethiopia
- Fiji
- Finland
- Gambia
- German Democratic Republic
- Germany, Federal Republic of
- Ghana
- Greece
- Holy See
- Honduras
- Hungary
- Iceland
- Indonesia
- Iran
- Iraq
- Ireland
- Italy
- Jamaica
- Japan
- Jordan
- Korea, Republic of
- Lebanon
- Lesotho
- Libyan Arab Jamahiriya
- Liechtenstein
- Luxembourg
- Madagascar
- Malaysia
- Maldives
- Mauritius
- Mexico
- Mongolia
- Morocco
- Nepal
- Netherlands (including Neth. Antilles)
- New Zealand
- Nicaragua
- Norway
- Paraguay
- Peru
- Philippines
- Poland
- Portugal
- Romania
- Samoa
- Senegal
- Singapore
- Sudan
- Suriname
- Swaziland
- Sweden
- Switzerland
- Thailand
- Turkey
- Uruguay
- Yugoslavia
- Zaire

green Non-Nuclear-Weapon States Party to NPT for which NPT Safeguards Agreements Are Not Yet in Force*

- Bahamas
- Bangladesh
- Barbados
- Benin
- Bolivia
- Botswana
- Burundi
- Central African Republic
- Chad
- Congo
- Democratic Kampuchea
- Democratic Yemen
- Egypt ▲
- Gabon
- Guinea-Bissau
- Grenada
- Guatemala
- Haiti
- Ivory Coast
- Kenya
- Lao People's Democratic Republic
- Liberia
- Mali
- Malta
- Nigeria
- Panama
- Rwanda
- St. Lucia
- San Marino
- Sierra Leone
- Somalia
- Sri Lanka
- Syrian Arab Republic
- Togo
- Tonga
- Tunisia
- Tuvalu
- United Republic of Cameroon
- Upper Volta
- Venezuela ■
- [Taiwan]■

red Non-Nuclear-Weapon States not Party to NPT in which IAEA Safeguards Agreements Are in Force on All Operating and Planned Nuclear Activities

Argentina
Brazil
Chile
Colombia
Cuba
Democratic People's Republic of Korea
Spain
Viet Nam

white Non-Nuclear-Weapon States not Party to NPT having No Significant Nuclear Activities

Albania
Algeria
Andorra
Angola
Bahrain
Belize
Bhutan
Burma
Cape Verde
Comoros
Djibouti
Equatorial Guinea
Guinea
Guyana
Kuwait
Malawi
Mauritania
Monaco
Mozambique
Nauru
Niger
Oman
Papua New Guinea
Qatar
Sao Tome and Principe
Saudi Arabia
Seychelles
Trinidad and Tobago
Uganda
United Arab Emirates
United Republic of Tanzania
Yemen Arab Republic
Zambia
Zimbabwe

yellow Non-Nuclear-Weapon States not Party to NPT in which Certain Nuclear Activities are **Not** under IAEA Safeguards

India
Israel
Pakistan
South Africa

violet Nuclear-Weapon States Party to NPT

Union of Soviet Socialist Republics
United Kingdom
United States of America

orange Nuclear-Weapon States not Party to NPT

China
France

* Except where indicated, States in this list have no significant nuclear activities.

■ All nuclear activities currently under IAEA safeguards (non-NPT).

▲ Small unsafeguarded research reactor.

THE STRUCTURE AND CONTENT OF AGREEMENTS BETWEEN THE AGENCY AND STATES REQUIRED IN CONNECTION WITH THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS

The Board of Governors has requested
the Director General
to use the material reproduced in this booklet
as the basis for negotiating safeguards agreements
between the Agency
and non-nuclear-weapon States
party to the Treaty on the Non-Proliferation
of Nuclear Weapons.

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PART I

BASIC UNDERTAKING

1. The Agreement should contain, in accordance with Article III.1 of the Treaty on the Non-Proliferation of Nuclear Weapons[1], an undertaking by the State to accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

APPLICATION OF SAFEGUARDS

2. The Agreement should provide for the Agency's right and obligation to ensure that safeguards will be applied, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices.

CO-OPERATION BETWEEN THE AGENCY AND THE STATE

3. The Agreement should provide that the Agency and the State shall co-operate to facilitate the implementation of the safeguards provided for therein.

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1) Reproduced in document INFCIRC/140.

IMPLEMENTATION OF SAFEGUARDS

4. The Agreement should provide that safeguards shall be implemented in a manner designed:

(a) To avoid hampering the economic and technological development of the State or international co-operation in the field of peaceful nuclear activities, including international exchange of *nuclear material*[2];

(b) To avoid undue interference in the State's peaceful nuclear activities, and in particular in the operation of *facilities;* and

(c) To be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

5. The Agreement should provide that the Agency shall take every precaution to protect commercial and industrial secrets and other confidential information coming to its knowledge in the implementation of the Agreement. The Agency shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of the Agreement, except that specific information relating to such implementation in the State may be given to the Board of Governors and to such Agency staff members as require such knowledge by reason of their official duties in connection with safeguards, but only to the extent necessary for the Agency to fulfil its responsibilities in implementing the Agreement. Summarized information on *nuclear material* being safeguarded by the Agency under the Agreement may be published upon decision of the Board if the States directly concerned agree.

6. The Agreement should provide that in implementing safeguards pursuant thereto the Agency shall take full account of technological developments in the field of safeguards, and shall make every effort to ensure optimum cost-effectiveness and the application of the principle of safeguarding effectively the flow of *nuclear material* subject to safeguards under the Agreement by use of instruments and other techniques at certain *strategic points* to the extent that present or future technology permits. In order to ensure optimum cost-effectiveness, use should be made, for example, of such means as:

(a) Containment as a means of defining *material balance areas* for accounting purposes;

(b) Statistical techniques and random sampling in evaluating the flow of *nuclear material;* and

(c) Concentration of verification procedures on those stages in the nuclear fuel cycle involving the production, processing, use or storage of *nuclear material* from which nuclear weapons or other nuclear explosive devices could readily be made, and minimization of verification procedures in respect of other *nuclear material,* on condition that this does not hamper the Agency in applying safeguards under the Agreement.

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2) Terms in italics have specialized meanings, which are defined in paragraphs 98—116 below.

NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL

7. The Agreement should provide that the State shall establish and maintain a system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement, and that such safeguards shall be applied in such a manner as to enable the Agency to verify, in ascertaining that there has been no diversion of *nuclear material* from peaceful uses to nuclear weapons or other nuclear explosive devices, findings of the State's system. The Agency's verification shall include, inter alia, independent measurements and observations conducted by the Agency in accordance with the procedures specified in Part II below. The Agency, in its verification, shall take due account of the technical effectiveness of the State's system.

PROVISION OF INFORMATION TO THE AGENCY

8. The Agreement should provide that to ensure the effective implementation of safeguards thereunder the Agency shall be provided, in accordance with the provisions set out in Part II below, with information concerning *nuclear material* subject to safeguards under the Agreement and the features of *facilities* relevant to safeguarding such material. The Agency shall require only the minimum amount of information and data consistent with carrying out its responsibilities under the Agreement. Information pertaining to *facilities* shall be the minimum necessary for safeguarding *nuclear material* subject to safeguards under the Agreement. In examining design information, the Agency shall, at the request of the State, be prepared to examine on premises of the State design information which the State regards as being of particular sensitivity. Such information would not have to be physically transmitted to the Agency provided that it remained available for ready further examination by the Agency on premises of the State.

AGENCY INSPECTORS

9. The Agreement should provide that the State shall take the necessary steps to ensure that Agency inspectors can effectively discharge their functions under the Agreement. The Agency shall secure the consent of the State to the designation of Agency inspectors to that State. If the State, either upon proposal of a designation or at any other time after a designation has been made, objects to the designation, the Agency shall propose to the State an alternative designation or designations. The repeated refusal of a State to accept the designation of Agency inspectors which would impede the inspections conducted under the Agreement would be considered by the Board upon referral by the Director General with a view to appropriate action. The visits and activities of Agency inspectors shall be so arranged as to reduce to a

minimum the possible inconvenience and disturbance to the State and to the peaceful nuclear activities inspected, as well as to ensure protection of industrial secrets or any other confidential information coming to the inspectors' knowledge.

PRIVILEGES AND IMMUNITIES

10. The Agreement should specify the privileges and immunities which shall be granted to the Agency and its staff in respect of their functions under the Agreement. In the case of a State party to the Agreement on the Privileges and Immunities of the Agency 3), the provisions thereof, as in force for such State, shall apply. In the case of other States, the privileges and immunities granted should be such as to ensure that:

(a) The Agency and its staff will be in a position to discharge their functions under the Agreement effectively; and

(b) No such State will be placed thereby in a more favourable position than States party to the Agreement on the Privileges and Immunities of the Agency.

TERMINATION OF SAFEGUARDS

Consumption or dilution of nuclear material

11. The Agreement should provide that safeguards shall terminate on *nuclear material* subject to safeguards thereunder upon determination by the Agency that it has been consumed, or has been diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or has become practicably irrecoverable.

Transfer of nuclear material out of the State

12. The Agreement should provide, with respect to *nuclear material* subject to safeguards thereunder, for notification of transfers of such material out of the State, in accordance with the provisions set out in paragraphs 92—94 below. The Agency shall terminate safeguards under the Agreement on *nuclear material* when the recipient State has assumed responsibility therefor, as provided for in paragraph 91. The Agency shall maintain records indicating each transfer and, where applicable, the re-application of safeguards to the transferred *nuclear material*.

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3) Reproduced in document INFCIRC/9/Rev. 2.

Provisions relating to nuclear material to be used in non-nuclear activities

13. The Agreement should provide that if the State wishes to use *nuclear material* subject to safeguards thereunder in non-nuclear activities, such as the production of alloys or ceramics, it shall agree with the Agency on the circumstances under which the safeguards on such *nuclear material* may be terminated.

NON-APPLICATION OF SAFEGUARDS TO NUCLEAR MATERIAL TO BE USED IN NON-PEACEFUL ACTIVITIES

14. The Agreement should provide that if the State intends to exercise its discretion to use *nuclear material* which is required to be safeguarded thereunder in a nuclear activity which does not require the application of safeguards under the Agreement, the following procedures will apply:

(a) The State shall inform the Agency of the activity, making it clear:

(i) That the use of the *nuclear material* in a non-proscribed military activity will not be in conflict with an undertaking the State may have given and in respect of which Agency safeguards apply, that the *nuclear material* will be used only in a peaceful nuclear activity; and

(ii) That during the period of non-application of safeguards the *nuclear material* will not be used for the production of nuclear weapons or other nuclear explosive devices;

(b) The Agency and the State shall make an arrangement so that, only while the *nuclear material* is in such an activity, the safeguards provided for in the Agreement will not be applied. The arrangement shall identify, to the extent possible, the period or circumstances during which safeguards will not be applied. In any event, the safeguards provided for in the Agreement shall again apply as soon as the *nuclear material* is reintroduced into a peaceful nuclear activity. The Agency shall be kept informed of the total quantity and composition of such unsafeguarded *nuclear material* in the State and of any exports of such material; and

(c) Each arrangement shall be made in agreement with the Agency. The Agency's agreement shall be given as promptly as possible; it shall only relate to the temporal and procedural provisions, reporting arrangements, etc., but shall not involve any approval or classified knowledge of the military activity or relate to the use of the *nuclear material* therein.

FINANCE

15. The Agreement should contain one of the following sets of provisions:

(a) An agreement with a Member of the Agency should provide that each party thereto shall bear the expenses it incurs in implementing its responsibilities thereunder. However, if the State or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so. In any case the Agency shall bear the cost of any additional measuring or sampling which inspectors may request; or

(b) An agreement with a party not a Member of the Agency should in application of the provisions of Article XIV.C of the Statute, provide that the party shall reimburse fully to the Agency the safeguards expenses the Agency incurs thereunder. However, if the party or persons under its jurisdiction incur extraordinary expenses as a result of a specific request by the Agency, the Agency shall reimburse such expenses provided that it has agreed in advance to do so.

THIRD PARTY LIABILITY FOR NUCLEAR DAMAGE

16. The Agreement should provide that the State shall ensure that any protection against third party liability in respect of nuclear damage, including any insurance or other financial security, which may be available under its laws or regulations shall apply to the Agency and its officials for the purpose of the implementation of the Agreement, in the same way as that protection applies to nationals of the State.

INTERNATIONAL RESPONSIBILITY

17. The Agreement should provide that any claim by one party thereto against the other in respect of any damage, other than damage arising out of a nuclear incident, resulting from the implementation of safeguards under the Agreement, shall be settled in accordance with international law.

MEASURES IN RELATION TO VERIFICATION OF NON-DIVERSION

18. The Agreement should provide that if the Board, upon report of the Director General, decides that an action by the State is essential and urgent in order to ensure verification that *nuclear material* subject to safeguards under the Agreement is not diverted to nuclear weapons or other nuclear explosive devices the Board shall be able to call upon the State to take the required action without delay, irrespective of whether procedures for the settlement of a dispute have been invoked.

19. The Agreement should provide that if the Board upon examination of relevant information reported to it by the Director General finds that the

Agency is not able to verify that there has been no diversion of *nuclear material* required to be safeguarded under the Agreement to nuclear weapons or other nuclear explosive devices, it may make the reports provided for in paragraph C of Article XII of the Statute and may also take, where applicable, the other measures provided for in that paragraph. In taking such action the Board shall take account of the degree of assurance provided by the safeguards measures that have been applied and shall afford the State every reasonable opportunity to furnish the Board with any necessary reassurance.

INTERPRETATION AND APPLICATION OF THE AGREEMENT AND SETTLEMENT OF DISPUTES

20. The Agreement should provide that the parties thereto shall, at the request of either, consult about any question arising out of the interpretation or application thereof.

21. The Agreement should provide that the State shall have the right to request that any question arising out of the interpretation or application thereof be considered by the Board ; and that the State shall be invited by the Board to participate in the discussion of any such question by the Board.

22. The Agreement should provide that any dispute arising out of the interpretation or application thereof except a dispute with regard to a finding by the Board under paragraph 19 above or an action taken by the Board pursuant to such a finding which is not settled by negotiation or another procedure agreed to by the parties should, on the request of either party, be submitted to an arbitral tribunal composed as follows: each party would designate one arbitrator, and the two arbitrators so designated would elect a third, who would be the Chairman. If, within 30 days of the request for arbitration, either party has not designated an arbitrator, either party to the dispute may request the President of the International Court of Justice to appoint an arbitrator. The same procedure would apply if, within 30 days of the designation or appointment of the second arbitrator, the third arbitrator had not been elected. A majority of the members of the arbitral tribunal would constitute a quorum, and all decisions would require the concurrence of two arbitrators. The arbitral procedure would be fixed by the tribunal. The decisions of the tribunal would be binding on both parties.

FINAL CLAUSES

Amendment of the Agreement

23. The Agreement should provide that the parties thereto shall, at the request of either of them, consult each other on amendment of the Agreement. All amendments shall require the agreement of both parties. It might additionally be provided, if convenient to the State, that the agreement of the

parties on amendments to Part II of the Agreement could be achieved by recourse to a simplified procedure. The Director General shall promptly inform all Member States of any amendment to the Agreement.

Suspension of application of Agency safeguards under other agreements

24. Where applicable and where the State desires such a provision to appear, the Agreement should provide that the application of Agency safeguards in the State under other safeguards agreements with the Agency shall be suspended while the Agreement is in force. If the State has received assistance from the Agency for a project, the State's undertaking in the Project Agreement not to use items subject thereto in such a way as to further any military purpose shall continue to apply.

Entry into force and duration

25. The Agreement should provide that it shall enter into force on the date on which the Agency receives from the State written notification that the statutory and constitutional requirements for entry into force have been met. The Director General shall promptly inform all Member States of the entry into force.

26. The Agreement should provide for it to remain in force as long as the State is party to the Treaty on the Non-Proliferation of Nuclear Weapons 1).

PART II

INTRODUCTION

27. The Agreement should provide that the purpose of Part II thereof is to specify the procedures to be applied for the implementation of the safeguards provisions of Part I.

OBJECTIVE OF SAFEGUARDS

28. The Agreement should provide that the objective of safeguards is the timely detection of diversion of significant quantities of *nuclear material* from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.

29. To this end the Agreement should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures.

30. The Agreement should provide that the technical conclusion of the Agency's verification activities shall be a statement, in respect of each *material balance area,* of the amount of *material unaccounted for* over a specific period, giving the limits of accuracy of the amounts stated.

NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL

31. The Agreement should provide that pursuant to paragraph 7 above the Agency, in carrying out its verification activities, shall make full use of the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement, and shall avoid unnecessary duplication of the State's accounting and control activities.

32. The Agreement should provide that the State's system of accounting for and control of all *nuclear material* subject to safeguards under the Agreement

shall be based on a structure of material balance areas, and shall make provision as appropriate and specified in the Subsidiary Arrangements for the establishment of such measures as:

(a) A measurement system for the determination of the quantities of *nuclear material* received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;

(b) The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;

(c) Procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements;

(d) Procedures for taking a *physical inventory;*

(e) Procedures for the evaluation of accumulations of unmeasured inventory and unmeasured losses;

(f) A system of records and reports showing, for each *material balance area,* the inventory of *nuclear material* and the changes in that inventory including receipts into and transfers out of the *material balance area;*

(g) Provisions to ensure that the accounting procedures and arrangements are being operated correctly; and

(h) Procedures for the provision of reports to the Agency in accordance with paragraphs 59—69 below.

STARTING POINT OF SAFEGUARDS

33. The Agreement should provide that safeguards shall not apply thereunder to material in mining or ore processing activities.

34. The Agreement should provide that:

(a) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in sub-paragraph (c) below is directly or indirectly exported to a non-nuclear-weapon State, the State shall inform the Agency of its quantity, composition and destination, unless the material is exported for specifically non-nuclear purposes;

(b) When any material containing uranium or thorium which has not reached the stage of the nuclear fuel cycle described in sub-paragraph (c) below is imported, the State shall inform the Agency of its quantity and composition, unless the material is imported for specifically non-nuclear purposes; and

(c) When any *nuclear material* of a composition and purity suitable for fuel fabrication or for being isotopically enriched leaves the plant or the process stage in which it has been produced, or when such *nuclear material,* or any other *nuclear material* produced at a later stage in the nuclear fuel cycle, is imported into the State, the *nuclear material* shall become subject to the other safeguards procedures specified in the Agreement.

TERMINATION OF SAFEGUARDS

35. The Agreement should provide that safeguards shall terminate on *nuclear material* subject to safeguards thereunder under the conditions set forth in paragraph 11 above. Where the conditions of that paragraph are not met, but the State considers that the recovery of safeguarded *nuclear material* from residues is not for the time being practicable or desirable, the Agency and the State shall consult on the appropriate safeguards measures to be applied. It should further be provided that safeguards shall terminate on *nuclear material* subject to safeguards under the Agreement under the conditions set forth in paragraph 13 above, provided that the State and the Agency agree that such *nuclear material* is practicably irrecoverable.

EXEMPTIONS FROM SAFEGUARDS

36. The Agreement should provide that the Agency shall, at the request of the State, exempt *nuclear material* from safeguards, as follows:

(a) Special fissionable material, when it is used in gram quantities or less as a sensing component in instruments;

(b) *Nuclear material,* when it is used in non-nuclear activities in accordance with paragraph 13 above, if such *nuclear material* is recoverable; and

(c) Plutonium with an isotopic concentration of plutonium-238 exceeding 80%.

37. The Agreement should provide that *nuclear material* that would otherwise be subject to safeguards shall be exempted from safeguards at the request of the State, provided that *nuclear material* so exempted in the State may not at any time exceed:

(a) One kilogram in total of special fissionable material, which may consist of one of more of the following:

(i) Plutonium;

(ii) Uranium with an *enrichment* of 0.2 (20%) and above, taken account of by multiplying its weight by its *enrichment;* and

(iii) Uranium with an *enrichment* below 0.2 (20%) and above that of natural uranium, taken account of by multiplying its weight by five times the square of its *enrichment;*

(b) Ten metric tons in total of natural uranium and depleted uranium with an *enrichment* above 0.005 (0.5%);

(c) Twenty metric tons of depleted uranium with an *enrichment* of 0.005 (0.5%) or below; and

(d) Twenty metric tons of thorium;

or such greater amounts as may be specified by the Board of Governors for uniform application.

38. The Agreement should provide that if exempted *nuclear material* is to be

processed or stored together with safeguarded *nuclear material,* provision should be made for the re-application of safeguards thereto.

SUBSIDIARY ARRANGEMENTS

39. The Agreement should provide that the Agency and the State shall make Subsidiary Arrangements which shall specify in detail, to the extent necessary to permit the Agency to fulfil its responsibilities under the Agreement in an effective and efficient manner, how the procedures laid down in the Agreement are to be applied. Provision should be made for the possibility of an extension or change of the Subsidiary Arrangements by agreement between the Agency and the State without amendment of the Agreement.

40. It should be provided that the Subsidiary Arrangements shall enter into force at the same time as, or as soon as possible after, the entry into force of the Agreement. The State and the Agency shall make every effort to achieve their entry into force within 90 days of the entry into force of the Agreement, a later date being acceptable only with the agreement of both parties. The State shall provide the Agency promptly with the information required for completing the Subsidiary Arrangements. The Agreement should also provide that, upon its entry into force, the Agency shall be entitled to apply the procedures laid down therein in respect of the *nuclear material* listed in the inventory provided for in paragraph 41 below.

INVENTORY

41. The Agreement should provide that, on the basis of the initial report referred to in paragraph 62 below, the Agency shall establish a unified inventory of all *nuclear material* in the State subject to safeguards under the Agreement, irrespective of its origin, and maintain this inventory on the basis of subsequent reports and of the results of its verification activities. Copies of the inventory shall be made available to the State at agreed intervals.

DESIGN INFORMATION

General

42. Pursuant to paragraph 8 above, the Agreement should stipulate that design information in respect of existing *facilities* shall be provided to the Agency during the discussion of the Subsidiary Arrangements, and that the time limits for the provision of such information in respect of new *facilities* shall be specified in the Subsidiary Arrangements. It should further be stipulated that such information shall be provided as early as possible before *nuclear material* is introduced into a new *facility.*

43. The Agreement should specify that the design information in respect of each *facility* to be made available to the Agency shall include, when applicable:

(a) The identification of the *facility*, stating its general character, purpose, nominal capacity and geographic location, and the name and address to be used for routine business purposes;

(b) A description of the general arrangement of the *facility* with reference, to the extent feasible, to the form, location and flow of *nuclear material* and to the general layout of important items of equipment which use, produce or process *nuclear material;*

(c) A description of features of the *facility* relating to material accountancy, containment and surveillance; and

(d) A description of the existing and proposed procedures at the *facility* for *nuclear material* accountancy and control, with special reference to *material balance areas* established by the operator, measurements of flow and procedures for *physical inventory* taking.

44. The Agreement should further provide that other information relevant to the application of safeguards shall be made available to the Agency in respect of each *facility,* in particular on organizational responsibility for material accountancy and control. It should also be provided that the State shall make available to the Agency supplementary information on the health and safety procedures which the Agency shall observe and with which the inspectors shall comply at the *facility.*

45. The Agreement should stipulate that design information in respect of a modification relevant for safeguards purposes shall be provided for examination sufficiently in advance for the safeguards procedures to be adjusted when necessary.

Purposes of examination of design information

46. The Agreement should provide that the design information made available to the Agency shall be used for the following purposes:

(a) To identify the features of *facilities* and *nuclear material* relevant to the application of safeguards to *nuclear material* in sufficient detail to facilitate verification;

(b) To determine *material balance areas* to be used for Agency accounting purposes and to select those *strategic points* which are *key measurement points* and which will be used to determine the *nuclear material* flows and inventories; in determining such *material balance areas* the Agency shall, inter alia, use the following criteria:

(i) The size of the *material balance area* should be related to the accuracy with which the material balance can be established;

(ii) In determining the *material balance area* advantage should be taken of any opportunity to use containment and surveillance to help ensure the completeness of flow measurements and thereby simplify the application of safeguards and concentrate measurement efforts at *key measurement points;*

(iii) A number of *material balance areas* in use at a *facility* or at distinct sites may be combined in one *material balance area* to be used for Agency accounting purposes when the Agency determines that this is consistent with its verification requirements; and

(iv) If the State so requests, a special *material balance area* around a process step involving commercially sensitive information may be established ;

(c) To establish the nominal timing and procedures for taking of *physical inventory* for Agency accounting purposes;

(d) To establish the records and reports requirements and records evaluation procedures;

(e) To establish requirements and procedures for verification of the quantity and location of *nuclear material;* and

(f) To select appropriate combinations of containment and surveillance methods and techniques and the *strategic points* at which they are to be applied.

It should further be provided that the results of the examination of the design information shall be included in the Subsidiary Arrangements.

Re-examination of design information

47. The Agreement should provide that design information shall be re-examined in the light of changes in operating conditions, of developments in safeguards technology or of experience in the application of verification procedures, with a view to modifying the action the Agency has taken pursuant to paragraph 46 above.

Verification of design information

48. The Agreement should provide that the Agency, in co-operation with the State, may send inspectors to *facilities* to verify the design information provided to the Agency pursuant to paragraphs 42—45 above for the purposes stated in paragraph 46.

INFORMATION IN RESPECT OF NUCLEAR MATERIAL OUTSIDE FACILITIES

49. The Agreement should provide that the following information concerning *nuclear material* customarily used outside *facilities* shall be provided as applicable to the Agency:

(a) A general description of the use of the *nuclear material,* its geographic location, and the user's name and address for routine business purposes; and

(b) A general description of the existing and proposed procedures for *nuclear material* accountancy and control, including organizational responsibility for material accountancy and control.

The Agreement should further provide that the Agency shall be informed on a timely basis of any change in the information provided to it under this paragraph.

50. The Agreement should provide that the information made available to the Agency in respect of *nuclear material* customarily used outside *facilities* may be used, to the extent relevant, for the purposes set out in sub-paragraphs 46(b)—(f) above.

RECORDS SYSTEM

General

51. The Agreement should provide that in establishing a national system of accounting for and control of *nuclear material* as referred to in paragraph 7 above, the State shall arrange that records are kept in respect of each *material balance area.* Provision should also be made that the Subsidiary Arrangements shall describe the records to be kept in respect of each *material balance area.*

52. The Agreement should provide that the State shall make arrangements to facilitate the examination of records by inspectors, particularly if the records are not kept in English, French, Russian or Spanish.

53. The Agreement should provide that the records shall be retained for at least five years.

54. The Agreement should provide that the records shall consist, as appropriate, of:

(a) Accounting records of all *nuclear material* subject to safeguards under the Agreement; and

(b) Operating records for *facilities* containing such *nuclear material.*

55. The Agreement should provide that the system of measurements on which the records used for the preparation of reports are based shall either conform to the latest international standards or be equivalent in quality to such standards.

Accounting records

56. The Agreement should provide that the accounting records shall set forth the following in respect of each *material balance area:*

(a) All *inventory changes,* so as to permit a determination of the *book inventory* at any time;

(b) All measurement results that are used for determination of the *physical inventory;* and

(c) All *adjustments* and *corrections* that have been made in respect of *inventory changes, book inventories* and *physical inventories.*

57. The Agreement should provide that for all *inventory changes* and *physical inventories* the records shall show, in respect of each *batch* of *nuclear material:* material identification, *batch data* and *source data.* Provision should further be included that records shall account for uranium, thorium and plutonium separately in each *batch* of *nuclear material.* Furthermore, the date of the *inventory change* and, when appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient, shall be indicated for each *inventory change.*

Operating records

58. The Agreement should provide that the operating records shall set forth as appropriate in respect of each *material balance area:*

(a) Those operating data which are used to establish changes in the quantities and composition of *nuclear material;*

(b) The data obtained from the calibration of tanks and instruments and from sampling and analyses, the procedures to control the quality of measurements and the derived estimates of random and systematic error;

(c) A description of the sequence of the actions taken in preparing for, and in taking, a *physical inventory,* in order to ensure that it is correct and complete; and

(d) A description of the actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss that might occur.

REPORTS SYSTEM

General

59. The Agreement should specify that the State shall provide the Agency with reports as detailed in paragraphs 60—69 below in respect of *nuclear material* subject to safeguards thereunder.

60. The Agreement should provide that reports shall be made in English, French, Russian or Spanish, except as otherwise specified in the Subsidiary Arangements.

61. The Agreement should provide that reports shall be based on the records kept in accordance with paragraphs 51—58 above and shall consist, as appropriate, of accounting reports and special reports.

Accounting reports

62. The Agreement should stipulate that the Agency shall be provided with an initial report on all *nuclear material* which is to be subject to safeguards

thereunder. It should also be provided that the initial report shall be dispatched by the State to the Agency within 30 days of the last day of the calendar month in which the Agreement enters into force, and shall reflect the situation as of the last day of that month.

63. The Agreement should stipulate that for each *material balance area* the State shall provide the Agency with the following accounting reports:

(a) *Inventory change* reports showing changes in the inventory of *nuclear material.* The reports shall be dispatched as soon as possible and in any event within 30 days after the end of the month in which the *inventory changes* occurred or were established; and

(b) Material balance reports showing the material balance based on a *physical inventory* of *nuclear material* actually present in the *material balance area.* The reports shall be dispatched as soon as possible and in any event within 30 days after the *physical inventory* has been taken.

The reports shall be based on data available as of the date of reporting and may be corrected at a later date as required.

64. The Agreement should provide that *inventory change* reports shall specify identification and *batch data* for each *batch* of *nuclear material,* the date of the *inventory change* and, as appropriate, the originating *material balance area* and the receiving *material balance area* or the recipient. These reports shall be accompanied by concise notes:

(a) Explaining the *inventory changes,* on the basis of the operating data contained in the operating records provided for under sub-paragraph 58(a) above; and

(b) Describing, as specified in the Subsidiary Arrangements, the anticipated operational programme, particularly the taking of a *physical inventory.*

65. The Agreement should provide that the State shall report each *inventory change, adjustment* and *correction* either periodically in a consolidated list or individually. The *inventory changes* shall be reported in terms of *batches;* small amounts, such as analytical samples, as specified in the Subsidiary Arrangements, may be combined and reported as one *inventory change.*

66. The Agreement should stipulate that the Agency shall provide the State with semi-annual statements of *book inventory* of *nuclear material* subject to safeguards, for each *material balance area,* as based on the *inventory change* reports for the period covered by each such statement.

67. The Agreement should specify that the material balance reports shall include the following entries, unless otherwise agreed by the Agency and the State:

(a) Beginning *physical inventory;*
(b) *Inventory changes* (first increases, then decreases);
(c) Ending *book inventory;*
(d) *Shipper/receiver differences;*
(e) Adjusted ending *book inventory;*
(f) Ending *physical inventory;* and
(g) *Material unaccounted for.*

A statement of the *physical inventory,* listing all *batches* separately and specifying material identification and *batch data* for each *batch,* shall be attached to each material balance report.

Special reports

68. The Agreement should provide that the State shall make special reports without delay:

(a) If any unusual incident or circumstances lead the State to believe that there is or may have been loss of *nuclear material* that exceeds the limits to be specified for this purpose in the Subsidiary Arrangements; or

(b) If the containment has unexpectedly changed from that specified in the Subsidiary Arrangements to the extent that unauthorized removal of *nuclear material* has become possible.

Amplification and clarification of reports

69. The Agreement should provide that at the Agency's request the State shall supply amplifications or clarifications of any report, in so far as relevant for the purpose of safeguards.

INSPECTIONS

General

70. The Agreement should stipulate that the Agency shall have the right to make inspections as provided for in paragraphs 71—82 below.

Purposes of inspections

71. The Agreement should provide that the Agency may make ad hoc inspections in order to:

(a) Verify the information contained in the initial report on the *nuclear material* subject to safeguards under the Agreement;

(b) Identify and verify changes in the situation which have occurred since the date of the initial report; and

(c) Identify, and if possible verify the quantity and composition of, *nuclear material* in accordance with paragraphs 93 and 96 below, before its transfer out of or upon its transfer into the State.

72. The Agreement should provide that the Agency may make routine inspections in order to:

(a) Verify that reports are consistent with records;

(b) Verify the location, identity, quantity and composition of all *nuclear* *material* subject to safeguards under the Agreement; and

(c) Verify information on the possible causes of *material unaccounted for, shipper/receiver differences* and uncertainties in the *book inventory.*

73. The Agreement should provide that the Agency may make special inspections subject to the procedures laid down in paragraph 77 below:

(a) In order to verify the information contained in special reports; or

(b) If the Agency considers that information made available by the State, including explanations from the State and information obtained from routine inspections, is not adequate for the Agency to fulfil its responsibilities under the Agreement.

An inspection shall be deemed to be special when it is either additional to the routine inspection effort provided for in paragraphs 78—82 below, or involves access to information or locations in addition to the access specified in paragraph 76 for ad hoc and routine inspections, or both.

Scope of inspections

74. The Agreement should provide that for the purposes stated in paragraphs 71—73 above the Agency may:

(a) Examine the records kept pursuant to paragraphs 51—58;

(b) Make independent measurements of all *nuclear material* subject to safeguards under the Agreement;

(c) Verify the functioning and calibration of instruments and other measuring and control equipment;

(d) Apply and make use of surveillance and containment measures; and

(e) Use other objective methods which have been demonstrated to be technically feasible.

75. It should further be provided that within the scope of paragraph 74 above the Agency shall be enabled:

(a) To observe that samples at *key measurement points* for material balance accounting are taken in accordance with procedures which produce representative samples, to observe the treatment and analysis of the samples and to obtain duplicates of such samples;

(b) To observe that the measurements of *nuclear material* at *key measurement points* for material balance accounting are representative, and to observe the calibration of the instruments and equipment involved;

(c) To make arrangements with the State that, if necessary:

(i) Additional measurements are made and additional samples taken for the Agency's use;

(ii) The Agency's standard analytical samples are analysed;

(iii) Appropriate absolute standards are used in calibrating instruments and other equipment; and

(iv) Other calibrations are carried out;

(d) To arrange to use its own equipment for independent measurement and surveillance, and if so agreed and specified in the Subsidiary Arrangements, to arrange to install such equipment;
(e) To apply its seals and other identifying and tamper-indicating devices to containments, if so agreed and specified in the Subsidiary Arrangements; and
(f) To make arrangements with the State for the shipping of samples taken for the Agency's use.

Access for inspections

76. The Agreement should provide that:
(a) For the purposes specified in sub-paragraphs 71(a) and (b) above and until such time as the *strategic points* have been specified in the Subsidiary Arrangements, the Agency's inspectors shall have access to any location where the initial report or any inspections carried out in connection with it indicate that *nuclear material* is present;
(b) For the purposes specified in sub-paragraph 71(c) above the inspectors shall have access to any location of which the Agency has been notified in accordance with sub-paragraphs 92(c) or 95(c) below;
(c) • For the purposes specified in paragraph 72 above the Agency's inspectors shall have access only to the *strategic points* specified in the Subsidiary Arrangements and to the records maintained pursuant to paragraphs 51—58 ; and
(d) In the event of the State concluding that any unusual circumstances require extended limitations on access by the Agency, the State and the Agency shall promptly make arrangements with a view to enabling the Agency to discharge its safeguards responsibilities in the light of these limitations. The Director General shall report each such arrangement to the Board.

77. The Agreement should provide that in circumstances which may lead to special inspections for the purposes specified in paragraph 73 above the State and the Agency shall consult forthwith. As a result of such consultations the Agency may make inspections in addition to the routine inspection effort provided for in paragraphs 78—82 below, and may obtain access in agreement with the State to information or locations in addition to the access specified in paragraph 76 above for ad hoc and routine inspections. Any disagreement concerning the need for additional access shall be resolved in accordance with paragraphs 21 and 22; in case action by the State is essential and urgent, paragraph 18 above shall apply.

Frequency and intensity of routine inspections

78. The Agreement should provide that the number, intensity, duration and timing of routine inspections shall be kept to the minimum consistent with

the effective implementation of the safeguards procedures set forth therein, and that the Agency shall make the optimum and most economical use of available inspection resources.

79. The Agreement should provide that in the case of *facilities* and *material balance areas* outside *facilities* with a content or *annual throughput,* whichever is greater, of *nuclear material* not exceeding five *effective kilograms,* routine inspections shall not exceed one per year. For other *facilities* the number, intensity, duration, timing and mode of inspections shall be determined on the basis that in the maximum or limiting case the inspection régime shall be no more intensive than is necessary and sufficient to maintain continuity of knowledge of the flow and inventory of *nuclear material.*

80. The Agreement should provide that the maximum routine inspection effort in respect of *facilities* with a content or *annual throughput* of *nuclear material* exceeding five *effective kilograms* shall be determined as follows:

(a) For reactors and sealed stores, the maximum total of routine inspection per year shall be determined by allowing one sixth of a *man-year of inspection* for each such *facility* in the State;

(b) For other *facilities* involving plutonium or uranium enriched to more than 5%, the maximum total of routine inspection per year shall be determined by allowing for each such *facility* $30 \times \sqrt{E}$ man-days of inspection per year, where E is the inventory or *annual throughput* of *nuclear material,* whichever is greater, expressed in *effective kilograms.* The maximum established for any such *facility* shall not, however, be less than 1.5 *man-years of inspection;* and

(c) For all other *facilities,* the maximum total of routine inspection per year shall be determined by allowing for each such *facility* one third of a *man-year of inspection* plus $0.4 \times E$ man-days of inspection per year, where E is the inventory or *annual throughput* of *nuclear material,* whichever is greater, expressed in *effective kilograms.*

The Agreement should further provide that the Agency and the State may agree to amend the maximum figures specified in this paragraph upon determination by the Board that such amendment is reasonable.

81. Subject to paragraphs 78—80 above the criteria to be used for determining the actual number, intensity, duration, timing and mode of routine inspections of any *facility* shall include:

(a) The form of *nuclear material,* in particular, whether the material is in bulk form or contained in a number of separate items; its chemical composition and, in the case of uranium, whether it is of low or high *enrichment;* and its accessibility;

(b) The effectiveness of the State's accounting and control system, including the extent to which the operators of *facilities* are functionally independent of the State's accounting and control system; the extent to which the measures specified in paragraph 32 above have been implemented by the State; the promptness of reports submitted to the Agency; their consistency with the Agency's independent verification;

and the amount and accuracy of the *material unaccounted for,* as verified by the Agency;

(c) Characteristics of the State's nuclear fuel cycle, in particular, the number and types of *facilities* containing *nuclear material* subject to safeguards, the characteristics of such *facilities* relevant to safeguards, notably the degree of containment; the extent to which the design of such *facilities* facilitates verification of the flow and inventory of *nuclear material;* and the extent to which information from different *material balance areas* can be correlated;

(d) International interdependence, in particular, the extent to which *nuclear material* is received from or sent to other States for use or processing; any verification activity by the Agency in connection therewith; and the extent to which the State's nuclear activities are interrelated with those of other States; and

(e) Technical developments in the field of safeguards, including the use of statistical techniques and random sampling in evaluating the flow of *nuclear material.*

82. The Agreement should provide for consultation between the Agency and the State if the latter considers that the inspection effort is being deployed with undue concentration on particular *facilities.*

Notice of inspections

83. The Agreement should provide that the Agency shall give advance notice to the State before arrival of inspectors at *facilities* or *material balance areas* outside *facilities,* as follows:

(a) For ad hoc inspections pursuant to sub-paragraph 71(c) above, at least 24 hours, for those pursuant to sub-paragraphs 71(a) and (b), as well as the activities provided for in paragraph 48, at least one week ;

(b) For special inspections pursuant to paragraph 73 above, as promptly as possible after the Agency and the State have consulted as provided for in paragraph 77, it being understood that notification of arrival normally will constitute part of the consultations; and

(c) For routine inspections pursuant to paragraph 72 above, at least 24 hours in respect of the *facilities* referred to in sub-paragraph 80(b) and sealed stores containing plutonium or uranium enriched to more than 5%, and one week in all other cases.

Such notice of inspections shall include the names of the inspectors and shall indicate the *facilities* and the *material balance areas* outside *facilities* to be visited and the periods during which they will be visited. If the inspectors are to arrive from outside the State the Agency shall also give advance notice of the place and time of their arrival in the State.

84. However, the Agreement should also provide that, as a supplementary measure, the Agency may carry out without advance notification a portion of the routine inspections pursuant to paragraph 80 above in accordance with

the principle of random sampling. In performing any unannounced inspections, the Agency shall fully take into account any operational programme provided by the State pursuant to paragraph 64(b). Moreover, whenever practicable, and on the basis of the operational programme, it shall advise the State periodically of its general programme of announced and unannounced inspections, specifying the general periods when inspections are foreseen. In carrying out any unannounced inspections, the Agency shall make every effort to minimize any practical difficulties for *facility* operators and the State, bearing in mind the relevant provisions of paragraphs 44 above and 89 below. Similarly the State shall make every effort to facilitate the task of the inspectors.

Designation of inspectors

85. The Agreement should provide that:

(a) The Director General shall inform the State in writing of the name, qualifications, nationality, grade and such other particulars as may be relevant, of each Agency official he proposes for designation as an inspector for the State;

(b) The State shall inform the Director General within 30 days of the receipt of such a proposal whether it accepts the proposal;

(c) The Director General may designate each official who has been accepted by the State as one of the inspectors for the State, and shall inform the State of such designations; and

(d) The Director General, acting in response to a request by the State or on his own initiative, shall immediately inform the State of the withdrawal of the designation of any official as an inspector for the State.

The Agreement should also provide, however, that in respect of inspectors needed for the purposes stated in paragraph 48 above and to carry out ad hoc inspections pursuant to sub-paragraphs 71(a) and (b) the designation procedures shall be completed if possible within 30 days after the entry into force of the Agreement. If such designation appears impossible within this time limit, inspectors for such purposes shall be designated on a temporary basis.

86. The Agreement should provide that the State shall grant or renew as quickly as possible appropriate visas, where required, for each inspector designated for the State.

Conduct and visits of inspectors

87. The Agreement should provide that inspectors, in exercising their functions under paragraphs 48 and 71—75 above, shall carry out their activities in a manner designed to avoid hampering or delaying the construction, commissioning or operation of *facilities,* or affecting their safety. In particular

inspectors shall not operate any *facility* themselves or direct the staff of a *facility* to carry out any operation. If inspectors consider that in pursuance of paragraphs 74 and 75, particular operations in a *facility* should be carried out by the operator, they shall make a request therefor.

88. When inspectors require services available in the State, including the use of equipment, in connection with the performance of inspections, the State shall facilitate the procurement of such services and the use of such equipment by inspectors.

89. The Agreement should provide that the State shall have the right to have inspectors accompanied during their inspections by representatives of the State, provided that inspectors shall not thereby be delayed or otherwise impeded in the exercise of their functions.

STATEMENTS ON THE AGENCY'S VERIFICATION ACTIVITIES

90. The Agreement should provide that the Agency shall inform the State of:

(a) The results of inspections, at intervals to be specified in the Subsidiary Arrangements; and

(b) The conclusions it has drawn from its verification activities in the State, in particular by means of statements in respect of each *material balance area,* which shall be made as soon as possible after a *physical inventory* has been taken and verified by the Agency and a material balance has been struck.

INTERNATIONAL TRANSFERS

General

91. The Agreement should provide that *nuclear material* subject or required to be subject to safeguards thereunder which is transferred internationally shall, for purposes of the Agreement, be regarded as being the responsibility of the State:

(a) In the case of import, from the time that such responsibility ceases to lie with the exporting State, and no later than the time at which the *nuclear material* reaches its destination; and

(b) In the case of export, up to the time at which the recipient State assumes such responsibility, and no later than the time at which the *nuclear material* reaches its destination.

The Agreement should provide that the States concerned shall make suitable arrangements to determine the point at which the transfer of responsibility will take place. No State shall be deemed to have such responsibility for *nuclear material* merely by reason of the fact that the *nuclear material* is in transit on or over its territory or territorial waters, or that it is being transported under its flag or in its aircraft.

Transfers out of the State

92. The Agreement should provide that any intended transfer out of the State of safeguarded *nuclear material* in an amount exceeding one *effective kilogram,* or by successive shipments to the same State within a period of three months each of less than one *effective kilogram* but exceeding in total one *effective kilogram,* shall be notified to the Agency after the conclusion of the contractual arrangements leading to the transfer and normally at least two weeks before the *nuclear material* is to be prepared for shipping. The Agency and the State may agree on different procedures for advance notification. The notification shall specify:

(a) The identification and, if possible, the expected quantity and composition of the *nuclear material* to be transferred, and the *material balance area* from which it will come;
(b) The State for which the *nuclear material* is destined ;
(c) The dates on and locations at which the *nuclear material* is to be prepared for shipping;
(d) The approximate dates of dispatch and arrival of the *nuclear material;* and
(e) At what point of the transfer the recipient State will assume responsibility for the *nuclear material,* and the probable date on which this point will be reached.

93. The Agreement should further provide that the purpose of this notification shall be to enable the Agency if necessary to identify, and if possible verify the quantity and composition of, *nuclear material* subject to safeguards under the Agreement before it is transferred out of the State and, if the Agency so wishes or the State so requests, to affix seals to the *nuclear material* when it has been prepared for shipping. However, the transfer of the *nuclear material* shall not be delayed in any way by any action taken or contemplated by the Agency pursuant to this notification.

94. The Agreement should provide that, if the *nuclear material* will not be subject to Agency safeguards in the recipient State, the exporting State shall make arrangements for the Agency to receive, within three months of the time when the recipient State accepts responsibility for the *nuclear material* from the exporting State, confirmation by the recipient State of the transfer.

Transfers into the State

95. The Agreement should provide that the expected transfer into the State of *nuclear material* required to be subject to safeguards in an amount greater than one *effective kilogram,* or by successive shipments from the same State within a period of three months each of less than one *effective kilogram* but exceeding in total one *effective kilogram,* shall be notified to the Agency as much in advance as possible of the expected arrival of the *nuclear material,* and in any case not later than the date on which the recipient State assumes re-

sponsibility therefor. The Agency and the State may agree on different procedures for advance notification. The notification shall specify:

(a) The identification and, if possible, the expected quantity and composition of the *nuclear material;*

(b) At what point of the transfer responsibility for the *nuclear material* will be assumed by the State for the purposes of the Agreement, and the probable date on which this point will be reached ; and

(c) The expected date of arrival, the location to which the *nuclear material* is to be delivered and the date on which it is intended that the *nuclear material* should be unpacked.

96. The Agreement should provide that the purpose of this notification shall be to enable the Agency if necessary to identify, and if possible verify the quantity and composition of, *nuclear material* subject to safeguards which has been transferred into the State, by means of inspection of the consignment at the time it is unpacked. However, unpacking shall not be delayed by any action taken or contemplated by the Agency pursuant to this notification.

Special reports

97. The Agreement should provide that in the case of international transfers a special report as envisaged in paragraph 68 above shall be made if any unusual incident or circumstances lead the State to believe that there is or may have been loss of *nuclear material,* including the occurrence of significant delay during the transfer.

DEFINITIONS

98. "Adjustment" means an entry into an accounting record or a report showing a *shipper/receiver difference* or *material unaccounted for.*

99. "Annual throughput" means, for the purposes of paragraphs 79 and 80 above, the amount of *nuclear material* transferred annually out of a *facility* working at nominal capacity.

100. "Batch" means a portion of *nuclear material* handled as a unit for accounting purposes at a *key measurement point* and for which the composition and quantity are defined by a single set of specifications or measurements. The *nuclear material* may be in bulk form or contained in a number of separate items.

101. "Batch data" means the total weight of each element of *nuclear material* and, in the case of plutonium and uranium, the isotopic composition when appropriate. The units of account shall be as follows:

(a) Grams of contained plutonium;

(b) Grams of total uranium and grams of contained uranium-235 plus uranium-233 for uranium enriched in these isotopes; and

(c) Kilograms of contained thorium, natural uranium or depleted uranium.

For reporting purposes the weights of individual items in the *batch* shall be added together before rounding to the nearest unit.

102. "Book inventory" of a *material balance area* means the algebraic sum of the most recent *physical inventory* of that *material balance area* and of all *inventory changes* that have occurred since that *physical inventory* was taken.

103. "Correction" means an entry into an accounting record or a report to rectify an identified mistake or to reflect an improved measurement of a quantity previously entered into the record or report. Each correction must identify the entry to which it pertains.

104. "Effective kilogram" means a special unit used in safeguarding *nuclear material*. The quantity in "effective kilograms" is obtained by taking:

(a) For plutonium, its weight in kilograms;

(b) For uranium with an *enrichment* of 0.01 (1%) and above, its weight in kilograms multiplied by the square of its *enrichment;*

(c) For uranium with an *enrichment* below 0.01 (1%) and above 0.005 (0.5%), its weight in kilograms multiplied by 0.0001; and

(d) For depleted uranium with an *enrichment* of 0.005 (0.5%) or below, and for thorium, its weight in kilograms multiplied by 0.00005.

105. "Enrichment" means the ratio of the combined weight of the isotopes uranium-233 and uranium-235 to that of the total uranium in question.

106. "Facility" means:

(a) A reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or

(b) Any location where *nuclear material* in amounts greater than one *effective kilogram* is customarily used.

107. "Inventory change" means an increase or decrease, in terms of *batches,* of *nuclear material* in a *material balance area;* such a change shall involve one of the following:

(a) Increases:

(i) Import;

(ii) Domestic receipt: receipts from other *material balance areas,* receipts from a non-safeguarded (non-peaceful) activity or receipts at the starting point of safeguards;

(iii) Nuclear production: production of special fissionable material in a reactor; and

(iv) De-exemption: reapplication of safeguards on *nuclear material* previously exempted therefrom on account of its use or quantity.

(b) Decreases:

(i) Export;

(ii) Domestic shipment: shipments to other *material balance areas* or shipments for a non-safeguarded (non-peaceful) activity;

(iii) Nuclear loss: loss of *nuclear material* due to its transformation into other element(s) or isotope(s) as a result of nuclear reactions;

(iv) Measured discard: *nuclear material* which has been measured, or estimated on the basis of measurements, and disposed of in such a way that it is not suitable for further nuclear use;

(v) Retained waste: *nuclear material* generated from processing or from an operational accident, which is deemed to be unrecoverable for the time being but which is stored;

(vi) Exemption: exemption of *nuclear material* from safeguards on account of its use or quantity; and

(vii) Other loss: for example, accidental loss (that is, irretrievable and inadvertent loss of *nuclear material* as the result of an operational accident) or theft.

108. "Key measurement point" means a location where *nuclear material* appears in such a form that it may be measured to determine material flow or inventory. "Key measurement points" thus include, but are not limited to, the inputs and outputs (including measured discards) and storages in *material balance areas.*

109. "Man-year of inspection" means, for the purposes of paragraph 80 above, 300 man-days of inspection, a man-day being a day during which a single inspector has access to a *facility* at any time for a total of not more than eight hours.

110. "Material balance area" means an area in or outside of a *facility* such that:

(a) The quantity of *nuclear material* in each transfer into or out of each "material balance area" can be determined; and

(b) The *physical inventory* of *nuclear material* in each "material balance area" can be determined when necessary, in accordance with specified procedures,

in order that the material balance for Agency safeguards purposes can be established.

111. "Material unaccounted for" means the difference between *book inventory* and *physical inventory.*

112. "Nuclear material" means any source or any special fissionable material as defined in Article XX of the Statute. The term source material shall not be interpreted as applying to ore or ore residue. Any determination by the Board under Article XX of the Statute after the entry into force of this Agreement which adds to the materials considered to be source material or special fissionable material shall have effect under this Agreement only upon acceptance by the State.

113. "Physical inventory" means the sum of all the measured or derived estimates of *batch* quantities of *nuclear material* on hand at a given time within a *material balance area,* obtained in accordance with specified procedures.

114. "Shipper/receiver difference" means the difference between the quantity of *nuclear material* in a *batch* as stated by the shipping *material balance area* and as measured at the receiving *material balance area.*

115. "Source data" means those data, recorded during measurement or calibration or used to derive empirical relationships, which identify *nuclear material* and provide *batch data.* "Source data" may include, for example, weight of compounds, conversion factors to determine weight of element, specific gravity,

element concentration, isotopic ratios, relationship between volume and manometer readings and relationship between plutonium produced and power generated.

116. "Strategic point" means a location selected during examination of design information where, under normal conditions and when combined with the information from all "strategic points" taken together, the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a "strategic point" may include any location where key measurements related to material balance accountancy are made and where containment and surveillance measures are executed.

PART III

SELECTED READINGS ON NUCLEAR SAFEGUARDS: 1967-1982

EXCERPT

REPORT TO THE ATOMIC ENERGY COMMISSION

By the Ad Hoc Advisory Panel on Safeguarding
Special Nuclear Material

MARCH 10, 1967

Ralph F. Lumb, Chairman

REPORT OF THE ADVISORY PANEL
ON
SAFEGUARDING SPECIAL NUCLEAR MATERIAL

I. Introduction and Abstract of Recommendations

With the inception of the nuclear age, the foreign policy of the United States crystalized on the objective of limiting the number of nuclear powers. The Baruch Plan to control nuclear weapons and to assure that special nuclear materials would be used principally for peaceful purposes was submitted to the United Nations in 1946, though it was never adopted. The Atoms for Peace Program was conditioned on, and recognized the need for, assurances that the materials transferred under the program would not be diverted to military pursuits. The incorporation of safeguards requirements in bilateral agreements for cooperation, and the systematic transfer by the United States of its bilateral safeguards responsibilities to the International Atomic Energy Agency is consistent with this objective. The United States ratification of the Moscow Treaty of 1963, the so-called "Limited Nuclear Test Ban Treaty," was the lineal descendant of this policy objective. Thus it has been, and continues to be, a basic foreign policy objective of the United States to strictly limit the proliferation of nations with nuclear weapons capability.

The accelerating introduction of nuclear power on an economically competitive basis in this country and abroad during the last two years has resulted in dramatic forecasts of nuclear power growth during the next decade or two. While the benefits of abundant and economic nuclear power are many and generally well-known, this development will inevitably result in the availability of large quantities of special nuclear materials. If uncontrolled, nuclear weapons development and production programs could be initiated in many countries. By 1980, it has been forecast,[9] plutonium will be produced throughout the world at a rate of more than 100 kilograms a day. Such quantities of material contain the potential for production of a substantial amount of the world's electric power. Alternatively, however, they are sufficient for the daily production of many nuclear weapons.

While it is unreasonable and unrealistic to terminate the nuclear power program because of its potential for contributing to the spread of nuclear weapons, the forecast by-product production of plutonium makes it essential that an effective world-wide international safeguards system be established quickly.

There are obviously a number of ways for non-nuclear nations to obtain a nuclear weapons capability, e.g.,

- the indigenous development of a technology capability;
- the acquisition of materials or finished weapons supplied for such purpose by a nuclear power;
- the theft of finished weapons components or assembled weapons; and
- the diversion of materials developed in, or supplied for, peaceful application of nuclear energy.

Attainment of the objectives of the non-proliferation policy accordingly involves a multifaceted program of formal and informal understandings, including:

- restricting the transfer of nuclear weapons and nuclear weapons technology to non-nuclear nations;
- inducements to such nations to refrain from independently developing nuclear weapons; and
- a safeguards program to protect against the diversion of materials to unauthorized purposes.

The safeguards program is designed to detect promptly, and thereby deter, diversions of special nuclear materials from peaceful programs to weapons applications. In the United States, the "safeguards" program is also expected to detect any diversion to unauthorized purposes of military materials, weapons, and weapons components, at least until they are transferred by the AEC to the Department of Defense.

The objectives of the safeguards program, properly implemented, can compel nations seeking nuclear arsenals to follow more expensive, and therefore less attractive, routes to nuclear weapons than would be the case if plutonium, for example, were acquired for military purposes as a by-product of a civilian nuclear power program.

Safeguards programs should also be designed in recognition of the problem of terrorist or criminal groups clandestinely acquiring nuclear weapons or materials useful therein. Although such illegal groups are more likely to steal finished components or weapons than divert materials from peaceful programs, criminal organizations may be attracted to divert such materials if a black market develops, as it is likely to. It should be recognized that political and social restraints would not influence terrorist, insurrectionist or criminal groups. Therefore, criminal sanctions, e.g., fines and prison terms, are essential elements of an effective safeguards program.

An international safeguards program can help reduce tensions and perhaps contribute useful precedents for effective disarmament and other peace keeping arrangements.

The Panel recognizes that even if successfully put into practice on a world-wide basis, the safeguards program by itself cannot effectively assure that this country's non-proliferation objectives will be attained. Nonetheless, for the reasons discussed above, the safeguards program is worthy of the active support of all interested governmental agencies.

The Panel believes that the AEC generally has been responsive, to its obligations, under the Atomic Energy Act, for safeguarding special nuclear materials. Over the past twenty years there has evolved a safeguards system applicable to AEC cost-type contractors which incorporates most of the essential elements for safeguarding special nuclear materials. The Panel notes that the AEC has recognized the need for modification of its safeguards program in the light of changing activities. The Panel generally concurs with the actions taken and contemplated.

The Panel has noted and recommends steps which the AEC can take to improve its programs. These recommendations are intended to promote a well coordinated, comprehensive safeguard system capable of coping with the rapid escalation in the distribution of nuclear technology and special nuclear materials.

Recommendations

1. The Atomic Energy Act of 1954 and the Atomic Weapons Rewards Act of 1955 should be modified to provide severe criminal penalties for unauthorized diversions of special nuclear materials and to provide rewards for information about such diversions. AEC regulations should require that these provisions be publicized and prominently posted at all installations handling significant* quantities of special nuclear materials.

2. a. Responsibility for policy making and overseeing the safeguards program should be vested in a single AEC office at a level sufficiently high that it can efficiently and economically coordinate this nation's domestic and international safeguards program.

   b. An Interagency Committee composed of representatives of sufficiently high stature from the AEC and such agencies as the Departments of Justice, State, Defense, Commerce, Treasury - as well as the Central Intelligence Agency and Arms Control and Disarmament Agency - should be established to formally involve these agencies in the safeguards program.

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*As used herein, significant quantities of special nuclear materials refer to quantities in excess of 5000 grams of contained uranium 235, uranium 233, plutonium, or any combination thereof.

(At the Commission's request, the Panel transmitted on January 20, 1967, its specific and detailed suggestions for an organizational structure designed to achieve these objectives.)

3. All persons having access to significant quantities of unclassified*special nuclear materials should have a clearance equivalent to "L" clearances which are used in the AEC Classified Information Access Program.

4. The AEC, in cooperation with its licensees, should develop minimum physical protection standards applicable to licensees for the safeguarding of special nuclear materials. These standards should take into consideration the strategic importance of special nuclear materials as well as their high dollar value.

5. There should be provisions made for a review by the AEC of the design and construction of facilities that handle significant quantities of special nuclear materials to determine their adequacy for safeguards purposes.

6. Criteria should be established for acceptable limits for shipper receiver differences, materials unaccounted for, quantities discarded or lost, and maximum quantities of special nuclear materials permitted on inventory in forms unmeasurable or which can be measured only with a very large

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*For classified materials, special clearances are required by AEC.

error, with due regard for the quantities, form and accessibility of the materials involved. In the event these limits are exceeded, the AEC should require an investigation and report.

7. The quantities and forms of special nuclear materials handled should be principal determinants in establishing the safeguards program. There should be established minimum quantities below which no special safeguards provisions are made.

8. Increased emphasis should be given to systems of internal management control within all organizations handling special nuclear materials in order to minimize the risk of diversions to unauthorized purposes.

9. The United States should intensify its efforts to establish an effective universal safeguards system under the International Atomic Energy Agency. Toward this end the U.S. should encourage:

a. Euratom and IAEA to arrange for appropriate surveillance by IAEA of the Euratom safeguards program, including active participation as appropriate in inspection of facilities;

b. Voluntary acceptance by other nations, especially the major powers, of the IAEA safeguards inspections;

c. The assignment by member nations of qualified personnel to the IAEA safeguards program for terms of at least five to seven years;

d. International pooling through the IAEA of information regarding diversions (actual, attempted, or potential) of special nuclear materials to unauthorized purposes.

10. a. The AEC should continue the present safeguards policy as provided for in the US-Euratom agreement for cooperation until Euratom and IAEA agree to surveillance by IAEA of the Euratom safeguards system.

b. The AEC should improve its evaluation of the effectiveness of the Euratom safeguards program.

11. The AEC should increase its research and development effort on safeguards techniques and should encourage and support other national and international efforts to improve safeguards.

12. The United States should encourage the International Atomic Energy Agency and other interested nations to establish an International School of Safeguards to train inspectors, develop research programs, and accumulate and distribute information relating to safeguards.

13. There should be an independent review of the safeguards currently applicable to materials and weapons transferred to the Department of Defense under Section 91b. of the Atomic Energy Act of 1954.

"Safeguards Against Nuclear Proliferation"
Remarks by Myron B. Kratzer
Director, Division of International Affairs
U. S. Atomic Energy Commission
for presentation at
George Washington University - American Assembly
Airlie House, Warrenton, Virginia
May 11, 1967

Mr. Chairman, Ladies & Gentlemen:

I am grateful for this opportunity to discuss before such a distinguished audience a subject which I believe has received far less attention than it deserves. At the present time, at least three nations - the United States, the United Kingdom, and Canada - and three international organizations - Euratom, the International Atomic Energy Agency, and the European Nuclear Energy Agency - are actively engaged in applying safeguards to assure that materials committed to peaceful uses of nuclear energy are not diverted to military purposes. These safeguards include on-site inspections by foreign nationals of the countries being inspected. Some 40 countries, including the United States, have entered into international agreements opening some or all of their peaceful nuclear activities to safeguards by one or more of the parties just mentioned.

Since undertaking its first international safeguards inspection in 1958, the U. S. Atomic Energy Commission has conducted nearly 700 inspections abroad in 29 countries. Euratom has carried out more than 650 inspections in its six member states, while the International Atomic Energy Agency is safeguarding more than 50 facilities in 23 countries.

About two years ago, in what we hoped would be a quantum jump in public awareness of safeguards, we arranged to have a member of the AEC safeguards staff appear on the television program "To Tell The Truth." This gentleman, Mr. John Downing, was then and now, to the best of our knowledge, the world's champion inspector, having completed as of now more than 180 inspections. I am unable to evaluate the results of Mr. Downing's appearance as far as increased public knowledge of safeguards is concerned, but at least the experience served to confirm our confidence in his extraordinary qualifications as an inspector, since the panel unanimously and unhesitatingly identified him as the real John Downing.

My serious point is that, possibly because safeguards are a going business, we tend to overlook the unprecedented nature of these arrangements under which so many nations have agreed to admit outside inspectors having broad powers of access and investigation to verify, and thus enforce, solemn international undertakings. In addition to their direct importance in assuring the peaceful use of nuclear material committed to that purpose, these arrangements are, I believe, an important step toward the creation of the institutions, the techniques, and the climate of confidence which can one day lead to the acceptance of disarmament measures of even broader significance.

I believe it is not unlikely that if, in the distant future, we live in a world where international order is securely founded on the rule of law, we may look back on the development of these safeguard arrangements as one of the significant early steps toward the achievement of this goal.

Obviously, the course of this development could not have been entirely smooth. The negotations to achieve the basic safeguards rights in bilateral agreements and international conventions were long, arduous, and often contentious. The development of safeguards systems to implement these rights has proven to be both technically and politically difficult.

None of these tasks is completed. But, I believe, when viewed in perspective, the achievements to date are creditable. This progress demonstrates the success which can be realized even in a difficult field when a long-term policy objective is adopted and given strong and persistent support by both the Executive and Legislative branches of our government. In this connection, special credit should be given to the Joint Congressional Committee on Atomic Energy and its staff for their vigorous and constructive efforts on behalf of safeguards.

What are these safeguards to which our government attaches so much importance? Who applies them, how effective are they, and what is their future?

In the technical sense, safeguards means a system of controls designed to detect diversion of materials committed to the peaceful use of atomic energy to a military purpose. Thus, in the direct sense, safeguards detect, rather than prevent, diversion.

Historically, safeguards came into being as a result of the desire on the part of nations who supplied peaceful nuclear assistance to other nations to demonstrate that this assistance was being employed exclusively for peaceful purposes. I have tried to choose these words carefully to stress the point that the motivation for safeguards has never been one of distrust of the solemn assurances provided by our partners, but rather of assuring all concerned that peaceful nuclear cooperation between friends is not diverted to military use. This is an objective which, far from being inimical to the interests of the safeguarded nation, serves its interests as well as our own.

This objective gives rise to a question of fundamental importance in the field of safeguards: by what organization should safeguards be applied?

At the outset, there was no alternative to the performance of safeguards by the U. S. itself, or by other supplier nations. Yet it was recognized ✓ from the outset that the full purpose of safeguards could be achieved only if they were carried out by an international organization of broad membership. Indeed, the U. S. bilateral safeguards program was undertaken at least in large measure to set the precedent and preserve the opportunity for the later application of safeguards by international organizations.

The reasons for this emphasis on international application of safeguards are simple but often misunderstood. If the sole objective of safeguards were to assure the United States that the assistance we have provided is not diverted to military purposes, that purpose could be met certainly most simply and perhaps most effectively by safeguards undertaken by U. S. inspectors. But the objective of satisfying the world at large that peaceful nuclear cooperation between partners is indeed peaceful, can be met only by safeguards applied by an international organization of such broad membership that its findings cannot be suspected of being self-serving or biased.

The corollary of wishing to assure other nations of the peaceful nature of our own nuclear cooperation is our own desire to be assured of the peaceful nature of cooperation between other nations. Just as some countries might doubt the validity of our bilateral safeguards, we might doubt the validity, or the technical adequacy of the safeguards of other nations.

The logical conclusion of the need to satisfy the world community as a whole of the peaceful nature of nuclear cooperation between many nations is a uniform system of international safeguards undertaken by, or verified by, an international organization of worldwide membership.

But if internationally administered safeguards have this advantage, we should not imagine that they present no problems. When we turn to international organizations for the application of safeguards, we inevitably lose the independent discretion we enjoy under our bilateral arrangements to determine the nature, and therefore the adequacy, of the safeguards. We must rely on the collective judgment of the international organization, and our ability to influence this judgment, to be certain that effective safeguards are applied.

Countries subject to inspection also sometimes express the concern that an international organization may not be subject to the same restraints as an individual friendly supplier nation to limit its safeguards to the degree necessary for effectiveness.

Our own experience indicates that these concerns, while understandable, need not be serious ones. The international organizations engaged in the application of safeguards, Euratom and the International Atomic Energy Agency, have been successful in achieving effective but unburdensome safeguards.

What are the technical elements and characteristics of an effective safeguard system? First of all, a practical system must be a graduated one; that is, the same effort cannot be expended to account for grams of fissionable material as for hundreds of kilograms. The intensity of safeguards must increase as the potential for diversion increases. This potential, in turn, depends upon the amount and form of fissionable material involved, and the nature of the operations or activities in which it is being employed.

Second, safeguards depend upon the existence of an effective local materials control system. This is essential to hold the cost and manpower requirements to acceptable levels, as well as to minimize intrusion of safeguards into plant operations. The technical principle of safeguards, therefore, is to verify the proper use of materials reflected by the local control system rather than to undertake this accounting in the first instance.

In practice, then, there are two basic elements in safeguards: the maintenance and review of records concerning the utilization of nuclear material; and the actual on-site inspections designed to determine the validity of these records. It is the on-site inspections which constitute the crucial element of a safeguards system; and it is this element, too, which makes safeguards a unique development in international relations.

On-site inspections, in turn, include two important elements. First are the steps involved in conducting a physical inventory of material to determine whether it complies with reported figures. The second are the measures of a physical security nature designed to determine directly whether there is any unauthorized removal of material.

The objective of safeguards is solely to determine whether any material has been diverted to unauthorized uses. To the extent that this can be accomplished without knowledge of the amounts of material present within the authorized activities, this information is not essential to the purposes of safeguards. In practice, however, the measurement of material quantities within a nuclear complex and the determination of a "material balance" - that is, making sure that outgo is equal to income less process losses and consumption - constitutes a powerful tool for assuring that diversion beyond specific and rather narrow limits has not occurred. However, it is a characteristic of this technique that while diversions beyond certain specific limits, based on the accuracy of available measurement methods, will be detected, complete accuracy cannot be achieved. Small diversions within the limits of accuracy of the measurements are likely to go undetected.

Physical security measures, on the other hand, while their effectiveness cannot be precisely evaluated, may, under some circumstances, detect a diversion well within the accuracy of measurement. The relative effectiveness and roles of these two kinds of safeguards measures can be likened to the activities of the auditor and the "cop-on-the-beat". From his examination of records and testing of inventory, the auditor will usually, in time, discover the removal of significant assets. The "cop-on-the-beat", if he is present at the right time, might observe a trivial theft, but could be unaware of even a major diversion during his absence. Thus, in safeguards as in more conventional systems of protection, the best answer seems to be a blend of techniques, each of which has different types of detection capabilities.

Physical security measures applicable to safeguards also include, as they do conventionally, techniques for "containment" of fissionable materials in locations where the potential for unauthorized removal is particularly high. This simply means that we sometimes may place locks or seals on areas where high-grade fissionable material is present in removable form, just as a bank places its cash in the vault. By ensuring that no transfers of material from these sealed areas take place except in the presence of an inspector, these locks and seals may eliminate or reduce the need for the physical presence of inspectors during the intervals between transfers.

These, then - materials accountability, surveillance, and containment - are, in greatly oversimplified terms, the basic techniques available for safeguards as we practice them today. The precise procedures to be followed by inspectors can only be developed on a case-by-case basis, through careful consideration of the characteristics of the facility or materials to be safeguarded. Even then, substantial flexibility must be left in the details of the procedure to be followed, since, as in any audit procedure, the element of uncertainty is a valuable tool of the inspector. The broader the rights of access afforded to inspectors, the less intensively it may be necessary to exercise them. At complex facilities handling nuclear material of weapons grade, continuous inspection is often necessary. Even here, however, the activities of the inspectors are concentrated on the material flow in the facility, and the safeguards function involves no interference with plant activities. Our conclusion is that continuous inspection can often be less intrusive than periodic inspections of greater intensity.

Whether we are dealing with periodic or continuous inspection, the guiding principle of safeguards is not that there must be inspection for inspections sake, rather that there must be adequate independent verification that peaceful nuclear material has not been diverted. This means that the safeguards authority should be able to determine by objective means, not dependent on the word of the inspected party, that there has been no diversion. When this can be accomplished without on-site inspection by personal means, well and good.

I am stressing this point because there are some who hope that, through improved techniques and equipment, much of the on-site inspection now necessary for effective safeguards may be eliminated. So long as the criterion of effective independent verification is maintained, this is a proper hope, and, as I shall note shortly, I believe that much can be accomplished in this direction.

How effective are the safeguards which we are able to apply to nuclear materials today? Unfortunately, this is a question which has no precise answer. I have already noted that materials accountability techniques have an inherent imprecision. In the critical operations in the nuclear fuel cycle, this imprecision is usually estimated at about 2 to 3%, and diversions well within this limit would not be detected or suspected with a high degree of certainty by materials accountability measures alone. Surveillance and containment can supplement the assurances, but with an effectiveness which is not subject to certain evaluation. No safeguards system, therefore, is foolproof, but we can say that safeguards systems which provide a high degree of assurance that diversion will be detected are practical. When this condition prevails, there is a strong deterrent against diversion by any would-be violator.

We believe that safeguards systems which accomplish this purpose can be operated without significant interference with plant operations, at costs which are very minor in comparison with the value of the nuclear power produced, and with personnel requirements which are well within the practical range. The application of safeguards by the IAEA to several U. S. facilities, including a large commercial power reactor, has demonstrated the validity of these conclusions. I believe there can be no better test of the United States belief in the reasonableness of the safeguard systems than its own position, which has been made clear over the years, that the nuclear powers should accept international safeguards on their own peaceful nuclear activities.

Today, we are at a crossroads in the evolution of safeguards. Progress in the negotiation of the nonproliferation treaty and other new factors have brought more intense and widespread attention to the subject than ever before. The question is sometimes posed whether safeguards are a necessary element of a nonproliferation treaty. There are some who feel that even without safeguards a widely agreed to treaty of nonproliferation would be better than none at all. I believe the case for including safeguards in a nonproliferation treaty from the outset is a compelling one.

The principle that international undertakings in the field of limitation of armaments - particularly nuclear armaments - are of such vital importance to U. S. and world security as to require verification has been a consistent feature of U. S. policy since the close of World War II. The application of safeguards to a nonproliferation treaty is, thus, not a novel idea or an afterthought, but an inevitable consequence of an unbroken line of U. S. policy. It is the opposite conclusion - that safeguards are unimportant to such a treaty - that would be surprising.

The concerns that have been expressed by some nations with regard to the safeguards provisions of the treaty have been given wide-spread publicity. In summary, these are that safeguards might hinder legitimate peaceful nuclear development by creating opportunities for industrial espionage and by interferring with the operation of peaceful nuclear facilities. The contention has been made that since these factors would be applicable only to the non-nuclear powers, who alone would be subject to safeguards under the treaty, they would result in a competitive advantage in the exploitation of the peaceful uses of nuclear energy in favor of the nuclear powers.

While it would be inappropriate to comment in detail on the negotiations now in progress, I believe that the discussions which have been held in connection with the safeguards provisions of the treaty have shed valuable light on the subject. These discussions have served to emphasize the point that safeguards are applied to provide assurance against diversion of nuclear material to unauthorized uses, and that they can and should do this with a minimum of access to equipment and facilities in which the material is used or produced. Insofar as possible, safeguards should be concentrated on strategic points in the flow of nuclear material where it can be most effectively measured and accounted for. Moreover, the discussions have focused valuable attention on the prospect for the much greater application of instruments to the task of safeguards. Such a development can reduce the cost and manpower requirements of safeguards, but, more importantly, it will make safeguards more acceptable by minimizing the access of inspection personnel to plants and facilities. A broadened program of research and development can contribute to progress in this field.

In general, therefore, we believe that the objections which have been raised to safeguards from the technical standpoint can be met, and that, in fact, the discussion of these objections has had a constructive effect on the future course of safeguards development.

One can understand that safeguards - even when applied along the lines suggested above - may not achieve popularity with the operators of nuclear plants. There are, however, major advantages to all signatory nations in providing for effective verification of a nonproliferation treaty.

In the absence of verification, the nonproliferation treaty amounts to a pledge on the part of each nonweapons signatory that it will not engage in the acquisition of nuclear weapons. There are already important examples in the world of countries who by agreement or unilateral action have publicly foregone the acquisition of nuclear weapons. Yet we know that, unfortunate and unjustified as it may be, these declarations have not always been accepted at face value by some other nations.

It seems clear to me that the most effective - possibly the only effective - means by which a nation can demonstrate the validity of its commitment to peaceful uses of nuclear energy is to place its program under effective international safeguards. If, through the absence of verification, there is a real or continued lack of confidence in the pledge of a nation which has signed the treaty, the result can only be to encourage its adversaries to take independent action to meet the threat which they believe, or pretend to believe, exists. This result would be injurious not only to world security as a whole, but particularly to the interests of any nation which has signed the treaty and is complying with its provisions, but whose good faith has been questioned, whether reasonably or otherwise. I do not see any conceivable disadvantage of properly administered safeguards which remotely overcome the advantages to all concerned of effective verification of the treaty. After all, it is the basic obligation of the treaty not to acquire nuclear weapons which limits the freedom of action of the non-weapons signatories. The only purpose of safeguards is to demonstrate compliance with this undertaking, and for the nation which has entered into it in good faith, the safeguards impose no further limitations whatsoever.

But there is another and perhaps even more important, even though intangible, advantage of a properly verified nonproliferation treaty. Under United States' leadership, the advanced nuclear nations, including the weapons powers, have long followed the policy of sharing the benefits of the peaceful uses of nuclear energy with other nations. For the United States, this cooperation would not have been possible without assurances that material assistance supplied by us would be employed only for peaceful purposes. Thanks to the assurances, our cooperation in the peaceful uses of nuclear energy has been comprehensive and fruitful. Nevertheless, these assurances have been largely confined so far to programs receiving direct outside assistance from the U. S. or other supplier nations. Our partners have been free to undertake nuclear weapons programs on their own, and this has inevitably exercised an inhibiting influence on some aspects of peaceful nuclear cooperation, effective as this has been. I believe it is clear that the conclusion of a nonproliferation treaty providing verified assurance of the peaceful nature of the entire nuclear programs of its nonweapons signatories, and not merely of programs based upon outside assistance, can only have an affirmative influence in strengthening and liberalizing worldwide cooperation in peaceful uses.

The nonproliferation treaty is first and foremost a covenant to limit the further spread of nuclear weapons. But it is, I believe, in a very important sense, also a doorway to the even more effective sharing and promotion of the peaceful uses of the atom.

CHAPTER 1

The Need for International Safeguards

HENRY D. SMYTH

THE TWO FACES OF NUCLEAR ENERGY

The destruction of two cities in Japan, each shattered and burned by a single nuclear bomb, ended World War II in August 1945. This bombing not only ended the war but revealed to the world the presence of a new and dramatically powerful source of energy. The fission of uranium had been announced to the scientific community in 1939, and its possible peaceful and military uses were soon recognized. Five years of secret development had shown how nuclear fission reactions could be made to occur either explosively, as in a bomb, or more slowly, as in a reactor, to produce a continuing source of heat convertible to electric power. Since 1945 there have been many nuclear explosions for weapons testing and some for exploring possible peaceful uses of such explosions themselves. No nuclear bombs have been used in warfare, but large stockpiles of such weapons and of nuclear materials have been built up in the United States and in a few other countries.

In 1945 demands for electric power were already growing rapidly, and resources of fossil fuel were beginning to be recognized as limited. Therefore the advent of a new source of energy, uranium, was welcomed with enthusiasm. Development of nuclear power plants was pushed vigorously in the United States and elsewhere, but only after twenty years or more did uranium fission begin to be of significance in the power picture. Nuclear power plants are now increasing rapidly and require increasing amounts of nuclear material for fuel.

Even before the nuclear bombs were dropped on Japan, many responsible people connected with their development recognized that a new dimension of horror was being added to warfare and privately urged plans for their control. Almost immediately after the war ended the United States took the initiative in proposing international control of nuclear materials and facilities. Such proposals recognized the close relation between the technology of nuclear weapons for war and the technology of nuclear power plants for peace. The dilemma was clearly posed: how can the dangers of nuclear war be reduced while the benefits of the peaceful uses of nuclear energy are exploited? Some progress has been made, but the current rapid increase of nuclear power plants planned or in being makes the need of control more urgent and the achievement of it more difficult than ever before.

Nuclear Power Plants

Production of the large amounts of electric power required by the modern world is done most efficiently in big central stations. Basically, such stations convert chemical energy or nuclear energy into heat, which is converted into steam, which drives generators which produce electric current. This is a clumsy, indirect process, wasting some 60 to 70 percent of the energy inherent in the original fuel, whether it be coal, gas, oil, or uranium—but it is the best we can do at present.

The waste heat produced by all steam-electric power plants must be dissipated, and this creates the problem of so-called thermal pollution. This type of pollution has become important more because of the enormous capacity of modern power plants than because some of them are nuclear, though a nuclear plant does produce more waste heat than a fossil fuel plant of the same size. In contrast, toxic pollution of the atmosphere from plants burning coal is much more serious than from nuclear plants. The routine discharge of small amounts of radioactive substances from nuclear plants can be and is controlled by proper design and operation. Exactly what limits are acceptable remain controversial. The nuclear plant must also be protected from accidents which might release a large amount of radioactivity from the core of the reactor.

Although very much concerned about these dangers, the general public remains remarkably relaxed about the product of nuclear power plants that concerns us in this book. Every nuclear power plant of the type now being built produces plutonium. Plutonium is a nuclear explosive. Even a small amount of plutonium in the hands of a terrorist group would be dangerous, and a supply of it is a major step toward a stockpile of nuclear bombs which a nation might use to wage nuclear war.

Nuclear War

The effects of nuclear war would be the direct destruction of whole cities or complexes of cities and the widespread fallout of radioactive debris. Fallout will not recognize national boundaries. Distance may attenuate its intensity, but neither rivers nor mountain ranges nor oceans will prevent its dissemination through the earth's atmosphere. A minor nuclear war where only a few weapons are dropped may seriously endanger only the combatant nations and their close neighbors. A major nuclear war will endanger the whole world.

These are the dangers that have confronted us ever since Hiroshima and Nagasaki. So far they have been avoided: nuclear bombs have not been used in war since 1945. While we must hope and pray that no more will ever be used, this can be assured only by eliminating war or by eliminating nuclear weapons. Regrettably, the attainment of either of these objectives appears unlikely in the near future.

Some argue that the danger of nuclear war is less now than it was ten or fifteen years ago because of the apparent lessening of international tensions and the growing realization that nuclear war is not likely to be profitable to either side. Others argue that nuclear war is becoming more probable because of increasing stockpiles of nuclear weapons, the increase from one to five in the number of countries having nuclear weapons (the United States, the Soviet Union, the United Kingdom, France, and China), and the spread of nuclear power plants with their inevitable production of plutonium. Debate between these two schools of thought seems somewhat academic. As long as the probability of nuclear war is finite, we should try to reduce it.

THE PRESENT STATUS OF NUCLEAR POWER

It is now of only historical interest to question whether the potential peaceful benefits of nuclear fission are sufficient to justify the dangers inherent in the spread of nuclear technology. Once the feasibility of nuclear bombs had been demonstrated, it would presumably have been impossible to prevent the eventual spread of nuclear technology to many countries. Acceptance of this view was implied in President Eisenhower's Atoms for Peace speech in 1953 and in subsequent U.S. policy. In effect, U.S. policy since 1953 has been to promote the technology of peaceful uses of nuclear energy, but at the same time to establish controls to prevent diversion of that technology to military use.

Numerous nuclear power plants have recently begun to operate or are under construction, located both in countries that have nuclear weapons and in those that do not. All these power plants produce plutonium. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) emerged from years of negotiation in the summer of 1968. By March of 1970 enough countries had become parties to the treaty to bring it into effect. Under the NPT, the parties to the treaty without nuclear weapons pledge not to develop or obtain them from other countries. Furthermore, these parties undertake to allow inspection of their peaceful nuclear activities to ensure that materials are not diverted from these activities to the manufacture of nuclear explosives. Such inspection is to be undertaken by the International Atomic Energy Agency (IAEA), an international organization established in 1956, with headquarters in Vienna, Austria, and a membership of more than one hundred countries.

By the spring of 1971, the IAEA had completed a revision of its "safeguards system" and had prepared a document to be used as a basis for the necessary safeguards agreements between the NPT parties and the IAEA. As of this writing, a number of such agreements have been negotiated. However, several important nations are delaying their adherence to the NPT, awaiting the outcome of other negotiations now in progress, principally those involving the members of the European Atomic Energy Community (Euratom).

In summary, the current question is what will be done through the NPT or otherwise to inhibit the diversion of nuclear material from peaceful purposes to the production of nuclear weapons.

WHAT ARE SAFEGUARDS?

If I were a student of the English language I would be tempted to write a scholarly essay on the increasing use of the word "safeguard." We hear it in TV commercials advertising a deodorant, in testimony before Congress by Department of Defense officials supporting ABM systems, and in many other contexts. Even in talk about nuclear energy, the word is used in several different senses. The U.S. Atomic Energy Commission insists that nuclear power plants must set up safeguards against pollution, worries about safeguards for the health of workers in plants handling radioactive materials, and may even declare how it is safeguarding the peace of the world by making more nuclear weapons. Though such multiple use of the word is confusing, I find a certain logic running through the various meanings. Let me provide a general definition before explaining the kind of safeguards that are the subject of this book.

The purpose of any safeguard or system of safeguards is to prevent some unwanted event or at least to reduce the likelihood of its occurrence—an umbrella is a safeguard against getting wet. The manufacture and use of automobiles are surrounded by an elaborate system of safeguards, including many types of inspection—but people are still killed by automobiles. Not only do automobiles endanger individual drivers, passengers, and pedestrians, but their large numbers in our cities produce smog which is both unpleasant and unhealthy.

The public has become increasingly concerned by the unwanted effects of automobiles and many other technologies of modern society. Belatedly, we are recognizing that our environment must be safeguarded against both immediate danger and ultimate destruction. Perhaps this concern has been stimulated by astronauts' photographs showing the limited size of the Earth, on which we all must live. Whatever the cause, general public concern needs to be translated into action, into establishing safeguards against the consequences of many technologies of modern life, old ones long neglected and new ones more readily dramatized. In particular, we need safeguards against the consequences of the discovery of nuclear energy and its uses in war and peace, a discovery often called the greatest technological breakthrough of modern time. To put this problem in perspective, I compare it with a much earlier discovery of even greater importance, about which we know almost nothing.

Surely the greatest technological breakthrough of all time occurred when prehistoric man learned how to use fire for his own purposes. Fire can be both beneficial and destructive. In using it, man had to learn how to control it, to prevent its spread. He did not always succeed, and he still fails to do so occasionally. The great Chicago fire of 1871 is supposed to have been started by Mrs. O'Leary's cow. In modern parlance, we can say that Mrs. O'Leary's system of domestic safeguards was inadequate or, what is more probable, was carelessly implemented. In Chicago even in 1871 there was a municipal safeguards system to prevent fires from spreading, the fire department. It, too, proved inadequate to meet the unusual conditions of long-continued heat and drought, wooden buildings, and a hot wind from the west. It is not clear whether the technology of fire fighting was insufficiently advanced to meet these conditions, or whether the planners of the fire department failed to anticipate the conditions that occurred, or whether the fire department was starved for men and equipment by the city fathers in the interest of economy. In other words, we do not know whether the safeguards system was inadequately designed or enfeebled for lack of financial support.

I have called the Chicago Fire Department a "municipal safeguards system," but of course fire departments are only one part of the system of safeguards against destruction by fire which men have developed over the centuries. There are building codes, restrictions on domestic heaters, ordinances controlling burning of brush or rubbish, inspection of public places like theaters, alarm systems, fire extinguishers, sprinkler systems—a whole system of regulations, instrumentation, and equipment aimed at preventing fire or limiting its spread. If we examine the components of this system of safeguards against destructive fire, we recognize that they serve three purposes: prevention, detection, or limitation.

The safeguards or systems of safeguards described in this book are concerned with preventing, detecting, or limiting the diversion of nuclear material from legitimate peaceful uses to illicit production of nuclear explosives. More specifically, in Chapters 5 and 7, where the prevention of theft of nuclear material by dissident groups or criminal organizations is discussed, it is clear that the safeguards system should involve physical protection such as vaults, locks, and guards as an important component. The safeguards systems described elsewhere in this book are primarily systems for keeping track of nuclear material. Accounting methods supplemented by sampling, analysis, and inspection are used to detect diversion of nuclear material from authorized use. Though not aimed directly at preventing diversion, such a positive system for detecting violations of the provisions of the Non-Proliferation Treaty can be expected to inhibit such violations and limit their extent.

THE IAEA AND SAFEGUARDS

The dangers inherent in the use of nuclear energy for peaceful purposes were clearly foreseen in 1956 by the drafters of the statute of the IAEA. Article II of the statute states: "The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."

The statute provides the legal basis for the establishment of a safeguards system, but the measures necessary to meet its objective took a long time to develop. There were many technical and political difficulties to be surmounted. Fortunately, the spread of nuclear power plants has also been slow, so that the need for international safeguards has become urgent only recently. Also, the Non-Proliferation Treaty, depending as it does on the IAEA safeguards system, has come along at about the right time. The revision and codification of the IAEA system required by the NPT has been done in the light of ten years' experience with safeguards on a gradually increasing scale.

One characteristic of the IAEA safeguards system under the NPT is the emphasis it places on the use of national safeguards systems. If a national government failed to keep a close record of the nuclear material within its borders, the IAEA would have to set up elaborate accounting and inventory procedures which would be both expensive and intrusive. Consequently, it is in the interest of any country adhering to the NPT to have a strong national system of material control. Such a system not only provides safeguards in the IAEA sense but serves other purposes of prudent management as well.

The criteria for a national safeguards system and an international system are similar, but the emphasis differs. Before discussing such criteria, it is well to review the technological sequence that must be present in a fully developed nuclear industry (this subject is fully discussed in Chapter 3, and is merely outlined here).

THE NUCLEAR FUEL CYCLE

1. The uranium ore is mined.
2. The uranium contained in the ore is concentrated and purified.
3. The proportion of the uranium-235 isotope is increased in an isotope enrichment plant. This step can be bypassed, but nuclear fuel containing slightly enriched uranium is now considered economically desirable in most circumstances.
4. The purified, enriched uranium is put into whatever form is desired as fuel for a nuclear power reactor.
5. The fuel is loaded into a reactor. After a period of operation often lasting as much as a year, the irradiated fuel is removed. By that time the fissionable uranium is partly used up, and other nuclei, including plutonium, have been produced, making fresh fuel desirable.
6. The spent fuel from the reactor, containing plutonium and other highly radioactive elements, is chemically reprocessed to separate the various elements.
7. The separated elements are stored, the residual uranium and plutonium for possible recycling and the other radioactive elements for possible special uses or merely to prevent random dissemination.

In actual practice, some of these seven steps may be combined in one plant or, on the other hand, broken up into substages.

As nuclear material moves through the fuel cycle, it varies in physical form (gaseous, liquid, or solid), in chemical composition, in isotopic ratio, and in degree of radioactivity. The general trend is toward increasing money value (e.g., enriched uranium is worth more than natural uranium) and increasing radioactivity (e.g., the spent fuel coming out of a nuclear power plant is far more radioactive than the fuel initially loaded).

The difficulty of determining amounts of material flowing past various points in the cycle varies greatly. For example, fuel assemblies being loaded into a reactor can be counted. They can be counted again when they are taken out—it's easy, just like putting thousand-dollar bonds in a safe deposit box and taking them out again. But something happens in the reactor; some uranium is converted into plutonium and into other elements. No change may be apparent in the outer protective sheathing in which the nuclear material is sealed, but the composition of the material is changed. The reactor operator would like to know the new composition, as would the manager of the chemical reprocessing plant that will handle the spent fuel, as would the nuclear material control officer. Satisfactory methods for getting this information are gradually being worked out, but it is a difficult technical problem. Similar difficulties arise in other steps of the fuel cycle.

The incentives to overcome such difficulties are different for the different groups of people that are involved. The plant management wants to avoid health hazards or loss of valuable material; the national government's supervisory agency wants to protect the environment and the health of the workers and to prevent illicit diversion of material to a black market. The international community shares the concern of the national government, but it also wants to be sure that the government itself is not engaged in diverting material to a nuclear weapon program.

Management can design the layout of its plants and the procedures of its operations to minimize loss of material and optimize conditions for inventory; it can insure physical protection of material by locks, vaults, guards, and instrumentation; it can make precise measurements of amounts of material at various points in the process; it can punish sloppy operation.

A national supervisory agency can check on the measures taken by the management, make independent analyses of effluents from the plant and of materials flowing past certain points. Above all, national authorities have police power, either through licensing or contracting processes or by direct regulatory laws. Consequently, if there are discrepancies between reports from plant management and direct inspections by a national authority, action can be taken.

An international agency has only such power as may be conferred upon it by international agreements. The Non-Proliferation Treaty gives the IAEA the right and the obligation to detect diversion of material to illicit use for the manufacture of nuclear explosives and to announce the evidence of such a diversion. The agency has no police power, but the NPT does give it authority to verify by independent inspection the reports it receives of the amounts and location of nuclear material in a country that is a party to the treaty.

In the preceding paragraphs, I have outlined some of the technical problems involved in detecting the diversion of nuclear material from legitimate channels to illicit uses and have mentioned in general terms the organizations involved. The application of these general ideas in actual practice requires many compromises, as experience in the United States has shown.

EXPERIENCE OF THE U.S. ATOMIC ENERGY COMMISSION

One might suppose that prudent management would want to minimize the amount of material that goes up the stack, down the drain, or into the scrap pile in any of the seven stages of the nuclear fuel cycle, particularly in the later stages. After all, 1 kilogram of plutonium is worth more than $9,000. Not only is money being wasted but hazards may be created. A good manager wants to know where every gram of material that comes into the plant finally ends up. This is not so easy, and is certainly much harder than for banks to check dollars in against dollars out. Furthermore, accounting for every gram of material can be very expensive, both as a result of high direct costs and because of interference with the smooth operation of the plant. From the point of view of management, a compromise must be made. Such a compromise may not always be satisfactory from the point of view of the national government.

There have been a few bad experiences with management in the United States. Although there has been no evidence of diversion, there have been a few cases where amounts of material have disappeared that were far above the reasonable errors that could result from technical difficulties of operation or analysis or accounting. If this merely meant loss of profits to the company involved, it would be a matter of private concern, but the implications of such a loss are much wider and involve the national government.

As we have pointed out, the national government has responsibilities for health, for conservation of scarce materials, and for prevention of possible diversion of material to illicit uses, as well as some concern for the economical operation of the plant. In the United States, the Atomic Energy Commission (AEC) is the organization primarily charged with these responsibilities.

IDEAL AND ACTUAL SAFEGUARDS

Ideally, the AEC would like to know where every gram of fissionable or radioactive material in the country is at any moment of time, extending the ideal for the manager of a single plant to the country as a whole. It is manifestly impractical to attain this goal: a perfect material control system is technically impossible to develop (even banks make mistakes), and its interference with operations and its high cost would make it unacceptable to industry. If the AEC tried to enforce such a system, there would be no nuclear energy industry.

Yet there must be a national safeguards system stringent enough to be effective in reducing almost to zero the probability of loss or diversion of significant amounts of material. Its regulations should insist on physical protection of the nuclear material at all stages and require inventories of material at appropriate stages. There must also be provisions for review of these inventories and for inspections to assure that the regulations are being carried out. Such reviews and inspections must be carried out by government employees of unassailable integrity. In short, the system must satisfy two criteria: technical effectiveness and credibility.

Two other criteria that must be considered are cost and acceptability. They are to a degree antithetical to the first two, as has been implied, but actually in the United States the necessity for good management in terms of the value of the material and of necessary health and safety measures is well recognized and generally accepted. Additional measures to safeguard against diversion as well are not usually troublesome in most parts of the fuel cycle, nor are the additional costs very great. In the past one has heard little complaint against such provisions per se.

Obviously the AEC must make a compromise between maximum technical effectiveness and credibility, on the one hand, and the limitations imposed by cost and acceptability of control measures, on the other. This is hard enough in a national system but much more difficult in an international safeguards system, as we shall see.

INTERNATIONAL SAFEGUARDS SYSTEMS

The basic objective of a national safeguards system is to prevent robbery or embezzlement. The additional objective assumed by an international safeguards system is to inhibit or detect nuclear diversion that might be authorized by a national government or by a dissident group in such a government. An international organization charged with administering a safeguards system in a number of countries will need the same kind of data required by a national authority administering a materials accounting system. Similarly, it must verify the accuracy of those data. In establishing an international system of safeguards, the same criteria must be borne in mind as have been mentioned for a national system, but so many new factors enter into the weighing of the criteria that the picture is substantially different. To prepare for detailed discussion in later chapters, some major problems are discussed below. For simplicity they are reviewed in terms of the IAEA.

Technical Effectiveness

The IAEA does not own any nuclear facilities, nor does it engage in or control the operation of any of the steps in the fuel cycle from mine to storage of residual material. It does not own any substantial amount of nuclear material. Its rights to administer safeguards arise from bilateral agreements between it and countries which are parties to the NPT or from pre-existing arrangements, usually involving a country that has imported nuclear materials and equipment and the country that has supplied them.

How, then, can the IAEA get the data it needs? The obvious way is to get them from the country involved. If that country does not have an adequate materials accounting system, the agency must insist that such a system be set up. If such an attempt is not successful or only partially successful, the technical effectiveness of the IAEA system will be impaired. Increasing the intensity of inspection would help, but the credibility of the international system might still be weakened.

Credibility

There are also credibility problems separate from those of technical effectiveness. Credibility is enhanced if there is some degree of adversary relationship between the IAEA inspectorate and the national staff. It would normally not be desirable to send a man to inspect country X who was a national of that country. By the same token, it would be unwise to send an inspector who would automatically be considered hostile by reason of his nationality.

The credibility of a regional safeguards system, such as that of Euratom, has been doubted on the ground that the members of Euratom are close allies and that there is consequently no adversary relationship. Others claim that the Euratom system is equivalent to a national system and is therefore of limited credibility. Supporters of the system argue that clearly most Euratom member countries want other members without nuclear weapons thoroughly safeguarded. The NPT gives the IAEA clear authority and responsibility to verify the effectiveness of national or regional systems by review of reports and by such actual inspections as may be appropriate. The question of whether a regional system is to be regarded as equivalent to a national system or to an international system is a difficult one which must be resolved by negotiation.

To summarize, assuming technical competence at all levels, credibility still depends on the nature of the organizations involved; for example, on whether they are industrial corporations, national governments, groups of allied governments, or international organizations of wide membership. In its fifteen years of existence, the IAEA, with a membership including almost every important nation, has built up a good reputation by its activities in many fields, including its voluntary safeguards system. Reasonable cooperation among its members should give the new system developed for NPT a high degree of technical and political credibility.

Financial Costs

In a national system of material control, some governmental authority usually has the responsibility for determining how elaborate the system can be without incurring unreasonable costs. Actually, the costs are quite low in relation to the value of the electric power produced in a nuclear power plant. In an international organization like the IAEA the situation is more complex. There are really three questions: the total cost of IAEA safeguards, the distribution of that cost among the members of the agency, and the division of costs between the agency and a particular country for safeguards under NPT in that country.

The Board of Governors of the IAEA has debated these questions at great length over the last several years. The general concern has been that the total cost should not be so great as to be out of proportion to the budget items for other activities of the agency, nor should it make the total agency budget an unreasonable burden on the member states, which pay for it by assessment. Present estimates of the probable costs of the safeguards system under the NPT are much lower than earlier guesses and are apparently acceptable. The reduction is partly the result of the emphasis on the use of national systems in the revised IAEA procedures.

The second problem was how to lessen the financial burden for small states unlikely to develop nuclear programs requiring safeguards. A formula has been worked out which recognizes the principle that non-proliferation is of importance to all members of the agency and yet sets a ceiling on the amounts to be paid by the smaller states. The total amounts of money involved are small. As to the division of costs between the agency and the state under safeguards, what might be called national accountability costs will be paid by the state concerned and verification costs by the agency. These cost arrangements are discussed further in Chapter 4.

Acceptability

The power of national governments to control activities within their borders varies enormously from country to country. Even totalitarian governments have to pay some attention to public opinion, or at least to the opinion of certain segments of the public. In the United States the AEC has the legal authority to require an adequate system of safeguarding nuclear material, but, as I have suggested, the exercise of such authority may be self-defeating if the proposed system is unreasonably complex and expensive. An international body like the IAEA has limited legal power. Although the non-nuclear-weapon states, parties to the NPT, are required by that Treaty to accept IAEA safeguards, no details of the system of safeguards are specified. The problem of acceptability for an international safeguards system is clearly more difficult than for a national system.

We sometimes think of international controls as impossible to achieve. Of course this is not so. We are not yet able to prevent the outbreak of war, but there is a long history of international agreements controlling activities in many fields. Examples range from the agreement to protect the sea otter (signed by the United States, the Soviet Union, the United Kingdom, and Japan in 1911) to the nuclear test ban treaty of 1963. As the interdependence of the nations of the world not only increases but becomes more obvious, more and more international agreements will be made, and the need of some means of enforcement will become clear. The notion of absolute sovereignty and independence will become obsolete.

Nevertheless, the idea that an international organization has the right to inspect perfectly legitimate industrial activities within the borders of a country is a radical one. It is designed to ameliorate a new and terrible danger—nuclear war. It is a tribute to the wisdom of the statesmen of the world that so many of them have recognized the danger and have accepted unusual measures to lessen it. Unfortunately, such wisdom is not universal. Acceptance of the NPT and of the IAEA safeguards system that it incorporates is not yet sufficiently complete to ensure the effectiveness of the Treaty, though a good start has been made.

The drafters of the Treaty and the IAEA group working on the safeguards system have been well aware of such objections to acceptance as danger of compromising industrial secrets, possible interference with plant operation, excessive cost, and infringement of sovereignty. The system chosen must provide affirmative answers to two questions:

1. Is the safeguards system mild enough to be acceptable to

the individual countries which already are, or are considering becoming, parties to the NPT?

2. Is the safeguards system strong enough to be acceptable to the community of nations as likely to deter the spread of nuclear weapons, as intended by the NPT?

Can the Criteria Be Met?

An international safeguards system must meet the four criteria that have been discussed: technical effectiveness, credibility, reasonable cost, and acceptability. To clarify the problem, consider two extreme cases. The IAEA could insist on keeping its own records of the flow of nuclear material through the fuel cycle and on making its own inventories of stockpiled material in each country. It could have resident inspectors at every one of the seven steps in the fuel cycle from ore to storage of residual material. Such a system would be technically effective and highly credible if the Agency itself maintained a good reputation, but it would be so expensive that the member nations of the IAEA would refuse to pay for it and so intrusive that countries with substantial nuclear installations would be unwilling to accept it. At the other extreme, the staff of the Agency inspectorate could sit in Vienna reading reports from national authorities without ever verifying their accuracy. Such an arrangement might appear technically effective on paper, but its credibility would be very low indeed. Of course the cost would be low and the system would be happily accepted by individual countries, but the community of nations could hardly be expected to view it as a significant deterrent to the spread of nuclear weapons.

The task of the IAEA in preparing for its role under the NPT has been to strike a balance between these two extremes. In approaching this task the Agency has had the benefit of ten years of experience with a more limited safeguards system. Such a system was first established in 1960 and has been extended and revised several times since. At present the Agency is administering safeguards in some thirty countries. Most of the installations involved are small, but certain large power reactors in Japan, India, the United Kingdom and the United States are included.

The IAEA is generally recognized as one of the most effective international organizations. Two factors, often cited as contributing to its success, are its limited objectives and the composition and broad authority of its Board of Governors. In April 1970, a few weeks after the NPT formally came into effect, the Board of Governors established a committee to review the IAEA safeguards system in the light of the Treaty. This committee was open-ended, that is, representatives of any of the 102 member states could participate in its deliberations. The Safeguards Committee met first in June 1970 and continued to meet in a series of sessions, each usually lasting two or three weeks, until March 1971. There were eighty-two sessions and, of course, innumerable bilateral or group discussions outside the meeting room, including at least one on Sunday at the swimming pool in the Prater. In an average session almost fifty countries would be represented, with a hard core of perhaps thirty-five to forty important countries always there.

The spirit and atmosphere of these meetings were remarkable. The problems before the group were recognized as difficult and important and were debated thoroughly and vigorously, with a minimum of irrelevant rhetoric. The Agency staff provided drafts of the necessary documents, defended them clearly and reasonably, and accepted innumerable amendments, which, in their turn, were fully debated.

Article III of the NPT provides that each non-nuclear-weapon state adhering to that Treaty shall negotiate an agreement with the IAEA for the administration of safeguards with regard to peaceful nuclear activities in its territory or under its control. The specific objective of the Safeguards Committee was to draw up a document which would guide the Agency in negotiating such agreements. The document, approved by the Board of Governors, was published by the Agency in May 1971 and is called the Negotiating Instructions.

The details of this document are discussed in later chapters of this book, and only some general comments will be made here. No one suggests that this is perfect or that the IAEA/NPT safeguards system it proposes will be 100 percent effective technically. The proposed international safeguards system depends heavily on the adequacy of national systems, and the provisions for reports and inspections are considered by many experts to be close to the minimum necessary for a viable system. If the parties to the NPT negotiate the necessary agreements with the IAEA in the same spirit shown by their delegates to the ad hoc Safeguards Committee, all will be well, but if they refuse to set up an adequate national system or balk at the suggested programs of inspection, negotiations may fail.

CONCLUSION

If the negotiations avoid the two dangers mentioned in the preceding paragraph, we will have a system of safeguards under the NPT that is a good compromise between effectiveness and credibility on the one hand and cost and acceptability on the other. Such a system will offer any country little excuse for staying out of the NPT on the ground that the safeguards system is either offensive to its national sensibilities or useless.

The negotiators of the NPT and the staff and membership of the IAEA have made a substantial step forward in the realm of international cooperation. Whatever the ultimate outcome, their example will remain important. If the governments of the world will recognize the desirability of limiting the spread of nuclear weapons and of verifying that limitation by a reasonable system of safeguards, they will adhere to the NPT and thus take a significant step away from nuclear war.

3. NPT safeguards

W. HÄFELE

Abstract

Safeguards of nuclear material have been a major point of concern since the early days of nuclear power. The first part of this chapter covers historical development of such safeguards and analyses the driving forces that led to that development. Special attention is given to the period of the early 1960s when peaceful applications of nuclear power became a category of its own for both nuclear-weapon as well as non-nuclear-weapon states. The establishment of a civilian nuclear fuel cycle and the flow of nuclear material in it are its most obvious characteristics.

This was the scope of the problem when the NPT came up, as negotiations had to embrace military considerations, alliance problems and questions on the civilian applications of nuclear energy. An analyses of this complex interweaving is attempted. It culminates in an assessment of the present situation and the accomplishments of NPT safeguards.

The final part deals with the problem of physical protection and more general applications of safeguards techniques that have been developed in the past years. Finally, the general context of the NPT is more explicitly considered in order to obtain a longer-range outlook.

I. *The first phase of the safeguards problem*

If an assessment of the present state of nuclear safeguards is to be made, it is useful to consider, at least briefly, the short history of safeguards in the use of nuclear energy. One can distinguish three phases in their history. The first phase began in 1945. At that time there was only one nuclear-weapon state, the United States of America, and on the surface the situation looked simple. The USA proposed from the beginning an international authority which would own or have managerial control of all nuclear material from the processing of ore in the mine to the end uses of such material. It was proposed to give the international authority the power to impose sanctions for minor violations, and to have a veto-free Security Council to deal with major violations. It was also suggested that a control system be set up after which the stockpile of nuclear weapons in the possession of the USA would be disposed of. This plan is known as the Baruch plan [1] after the US Ambassador to the United Nations at that time.

W. Haefle. NPT safeguards. In Nuclear Proliferation Problems. c1974. pp. 142-154. Reprinted with permission, Stockholm International Peace Research Institute.

This plan did not materialize. The Soviet Union made a counterproposal that left nuclear resources in national hands and gave the international authority only the power to conduct certain inspections. It then became impossible to agree on control and inspection procedures and the arms race began. It was really only the military use of nuclear energy that was of interest. The term "military use" refers here to both the design and construction of weapons and the nuclear propulsion devices for submarines and ships. By 1955 the stockpiles of nuclear weapons had grown so large that it seemed impossible to give satisfactory assurances of their elimination no matter what the procedures would be. Because of this problem the United States also officially dropped the Baruch plan. It is noteworthy that this was as late as September 1955. Of course, the problem of the stockpile of nuclear weapons persisted. International negotiations on arms control and disarmament since 1955 have been characterized by the problem of fissionable material production cut-off and transfer.

II. *The US Atomic Energy Acts, the second phase of safeguards and the Treaty of Rome*

Complementary to the international development of safeguards is their development within the United States. The Atomic Energy Act of 1946 placed a strict embargo on the export of nuclear information and material with the explicit hope that such a policy could halt the proliferation of nuclear weapons. The atomic bomb explosions by Great Britain and the Soviet Union, however, demonstrated that this policy had failed. By 1953 the nuclear monopoly of the USA no longer existed and the problem of non-proliferation became much more complex. The US side then established a new approach to the problem which marked the beginning of the second phase of safeguards.

The principal idea of that second phase was to encourage the peaceful uses of atomic energy by providing an incentive for the transfer of fissionable material from the military domain to the civilian domain. This idea was enhanced by the growing recognition of the fact that the peaceful uses of atomic energy might indeed become important one day. The starting point for this new policy was the famous speech of President Eisenhower before the UN General Assembly in December 1953. Accordingly, inside the USA a new Atomic Energy Act replaced the one of 1946. It is useful to recall the senate report on the envisaged 1954 atomic energy legislation.

> Today we are not alone in the drive to achieve peacetime atomic power. Eight years ago, besides the United States, only the United Kingdom, Canada, and—as we have recently come to find—the Soviet Union had major atomic energy projects in being. The possibility of cooperation with other nations to gain mutual advantage in the areas of peacetime power appeared far in the future. As against

this, however, more than 20 countries now have vigorous atomic energy programs, and several of them are pressing toward the construction of atomic power plants to turn out useful amounts of electricity. [1]

The resulting 1954 Atomic Energy Act did provide for international cooperation in the field of the peaceful uses of atomic energy. Against the background of what has been said about the first phase of the history of safeguards it is natural that this new legislation insists on inspection and verification of the peaceful uses of the atom in international cooperation.

In order to expedite this plan, the USA brought forward the idea of creating the International Atomic Energy Agency (IAEA). It was hoped that all cooperation, specifically the transfer of nuclear material, would be channelled through this agency. The IAEA was therefore expected to be the principal instrument for the transfer of nuclear material from the military to the civilian domain.

The third big event that got the programme for the peaceful uses of atomic energy started was the first International Conference on the Peaceful Uses of Atomic Energy at Geneva in 1955. The success of this conference was overwhelming and in response there was a truly worldwide enthusiasm for the development of the peaceful uses of atomic energy.

The IAEA in Vienna grew slowly. Many partners were uncertain about their eventual success but many bilateral contacts developed. Most of them were between non-nuclear-weapon states and nuclear-weapon states, chiefly the USA, because at that time high posture in the field of military uses of nuclear energy was synonymous with high posture in the field of peaceful uses of atomic energy. Other instances of bilateral cooperation were the Dutch-Norwegian and the Canadian-Indian programmes.

The transfers of nuclear material that were made through the IAEA were limited. Today it is clear that those transfers did not have the impact on the arms race that was hoped for at the time of the foundation of the IAEA. Nevertheless, the agency developed steadily and became a major instrument in helping lesser developed nations make use of the benefits of the atom, especially in the application of radioactive isotopes. The importance of that development and its significance for the underdeveloped countries is sometimes underestimated.

The agreements on cooperation that were concluded by the USA provided for: the exchange of information, the transfer of nuclear material and the transfer of equipment including complete reactors. The idea of safeguards was relevant to all three areas. Safeguards adhered to the elements that came from the nuclear-weapon states.

In many cases the safeguards required by the Atomic Energy Act of 1954 were to be implemented by the IAEA; it was therefore necessary for this agency to set up a safeguards system. In the early years of the 1960s the non-nuclear-weapon states, while receiving cooperation from the USA and other nuclear-weapon states, had nevertheless developed elements of the peaceful uses of atomic energy of their own. The original safeguards system of the IAEA therefore distinguished sharply between nuclear material to be safeguarded that came from nuclear-weapon states via the IAEA and nuclear material not subject to safeguards. Further, in the early 1960s the isolated nuclear facility was the focus of interest. In many cases this was a research reactor, say a swimming pool reactor, which had no fuel cycle. The power of such facilities was too small to produce something like a technical flow of fissionable material since 1 g/day of nuclear material corresponds with 1 MW(th). Accordingly, the safeguards provisions of the early IAEA system concentrated on these isolated nuclear facilities as such. The impact of large power reactors and their related fuel cycle was not yet felt. The document that describes the procedures of this early IAEA safeguards system is IAEA Document INFCIRC/66 with its revisions 1 and 2. [2] The procedures there are described in fairly broad terms that allow for a wide spectrum of interpretation. The peaceful uses of atomic energy were not yet commercially and industrially significant when the original document was conceived and adopted by the Board of Governors of the IAEA.

During the second phase of safeguards the Treaty of Rome was signed, thus constituting the European Community in general as a part of the European Atomic Energy Community, Euratom. The concept of that community was very broad; nothing less than the unification of Europe. The peaceful uses of atomic energy therefore had a very broad scope politically, geographically and technically. The treaty that constitutes Euratom has article 7 on safeguards as a cornerstone of the whole arrangement. It is preceded by article 6 on the supply of nuclear material. Supply and safeguards of nuclear material as key components of the discussion on arms control and disarmament indeed reappear in the Treaty of Rome. Their inclusion in that treaty is important as a matter of principle. The signatory states abandon their sovereign rights in respect to safeguards of nuclear material in a legally binding form, permanently and not only on the occasion of special transfer of such material. The safeguards provision of the Euratom treaty are, accordingly, very universal. Similarly, according to that treaty there is no ownership of nuclear material; the various users of nuclear material only process that material, the ultimate title being with the Euratom Supply Agency.

This powerful and far reaching concept of ownership and safeguards of nuclear material within Euratom developed parallel to the IAEA under the assumption that the peaceful industrial and commercial uses of atomic energy would come at a time when the concept of the common market had fully materialized.

The practical implementation of the peaceful applications of atomic energy was more complex. Enriched uranium and plutonium were available in larger quantities only from the United States. According to the basic ideas of the Atomic Energy Act of 1954, a far-reaching agreement of cooperation was made which included the aspects of safeguards. Safeguards required by the Atomic Energy Act were identified with Euratom safeguards and this led to the concept of their verification by the USA. The practical situation that evolved can be described by saying that it was a cross between the Euratom Treaty of Rome of 1957 and the US Atomic Energy Act of 1954.

III. *The early 1960s*

The slow but steady evolution of arms control and disarmament led to the third phase of the history of safeguards. Plans for a General and Complete Disarmament (1962) to be negotiated by an Eighteen Nations Disarmament Committee (ENDC) had been arrived at after several intermediary stages including: the Western proposal for a certain package deal in 1957, the Ten Nations Disarmament Committee of 1960, the US Program for General and Complete Disarmament of 1961, the Swedish UN resolution on the creation of a non-nuclear club of 1961 and an Irish resolution also of 1961. The idea not to transfer nuclear weapons from nuclear-weapon states to non-nuclear-weapon states and to freeze the existing strategic situation was the concept for the start of the ENDC. All this appears very similar to what had been attempted in the 1950s but the points of principle arose from some strategically relevant developments in weapon technology:

(a) The technological possibility of having hardened missile silos was demonstrated and implemented.

(b) The software for that hardware, that is the strategic concept, was provided for by a number of outstanding thinkers in the USA. The name of Jerome Wiesner has to be mentioned here.

(c) Technology had reached a point where reconnaissance, delivery and the nuclear warhead established a consistent weapon system that was capable of reaching any point on the globe. The globe was no longer "unlimited"; it had become small.

These technological developments had changed the world at a fundamental level. Moreover, arms control and disarmament problems were no longer those of the 1950s; they, too, had changed.

The ENDC started its work in 1962 but it was 1964 when a proposal of President Johnson introduced the concept of non-proliferation and freezing that stimulated the work of the ENDC so clearly. It was also at that time that the peaceful applications of the atom experienced a breakthrough from the state of R&D to the stage of industrial and commercial build-up. I refer to the Oyster Creek event. In December 1963 the Jersey Central Power and Light utility ordered a boiling water reactor from General Electric on purely commercial grounds. A boom of ordering LWRs followed in the USA. Today the capacity of nuclear power plants that are firmly ordered, under construction or in operation totals roughly 100 000 MW(e).

The salient point is that shortly thereafter, in 1966, two nuclear power stations were ordered in Germany (Stade and Würgassen) also on purely commercial grounds.

In a number of industrialized non-nuclear-weapon states the development of the peaceful applications of nuclear energy grew more and more successful. The development was never conceived as an extension of a basically military development but was conceived and implemented as a development on its own grounds and merits. The cheap production of electricity was only the peak of an iceberg. In the 1950s and 1960s it became obvious what modern technologies meant to an industrialized nation. Strong impulses for innovation were obtained by the development of such technologies. Nuclear energy was the forerunner and a prototypical venture. What weapon development was for the nuclear-weapon states, the development of civilian major technologies was for the non-nuclear-weapon states: ventures for innovation and progress. The worldwide debate and reflection on big science of these years is indicative of that. On the meaning of big science and its impact on modern industrialized non-nuclear-weapon states, a book written by Ryukichi Imai serves as an example of these far-reaching considerations. [3] Among other things this also meant that no longer was a high posture in the field of the peaceful uses of atomic energy synonymous with a high posture in the field of military uses of atomic energy. The peaceful uses had started to become a category on their own. This is the background against which the advent of the NPT has to be seen.

IV. *The third phase of safeguards*

In the mid 1960s, the NPT safeguards presented two main problems, one political and the other technical.

The political problem is obvious if one considers the original drafts of the NPT. The US draft required in article III, IAEA or equivalent international safeguards, thus permitting Euratom safeguards to be on an equal footing with IAEA safeguards. One has to bear in mind that the size and experience of the Euratom safeguards were larger than those of the IAEA, at least in the second half of the 1960s. Also the political embedding of Euratom safeguards in the Treaty of Rome was more comprehensive. In the years that were politically characterized by the key word of the bipolar strategic equilibrium, the whole problem was, apart from one of prestige, a question of the structure of alliances. This political problem was emphasized by the fact that both safeguards systems were not very specific. It was not clear to what extent they were complementary to one another or simply parallel.

The other problem was equally complex. The word technical hardly describes it adequately. It was mentioned before that the peaceful application of nuclear energy had much matured both in nuclear-weapon states and in industrialized non-nuclear-weapon states. All non-nuclear-weapon states were possibly ready to admit that the global security question indeed required an inequality in the military domain. Of course, military inequalities have always occurred in history. But there had never been a demand to legalize such inequalities on a worldwide basis and to perpetuate them indefinitely. This demand was unique; even so the non-nuclear-weapon states were eventually ready to accept that, but they insisted on not establishing by the same token, an inequality in the civilian domain. Recall that in the 1960s it began to be possible to have a high posture in the peaceful applications of the atom with no posture whatsoever in military applications. A sharp decoupling of the military and peaceful applications of the atom was the issue at stake.

This debate sometimes took unexpected directions, for instance concerning the problem of fallout or spin-off. It was argued that this spin-off would be significant and would put the nuclear-weapon-states into a technologically superior position in the civilian domain forever. Such a claim was not without substance although it turned out that this was again a complex problem. On the surface there was no tangible evidence for such spin-off. But one must realize that the low price for separative work that was, and still is, offered by the USA and other nuclear-weapon states was possible only because the diffusion plants were larger, and they were large because of military requirements. Without such low prices for separative work the commercial breakthrough of the light water reactor would not have been possible that early. It was therefore more a capacitive fallout than a straightforward technical fallout. The whole debate was highlighted by the debate on the technological gap.

Another problem was that of competition between a nuclear-weapon state and a non-nuclear-weapon state in the field of commercial applications of the peaceful atom. Nuclear-weapon states should not have an advantage there simply because there was inequality in the military domain. That this should be appropriately expressed in the final text of the NPT was therefore demanded, as well as that safeguards of nuclear weapons be applied to all partners equally, irrespective of their weapon status. This whole argument is somehow highlighted by the insertion of article IV in the final text of the NPT. This follows from the idea of the equality of all states in the civilian domain. To some extent this is also true for article V. Both articles were not contained in the various early drafts of the NPT. In my judgement the existing form of the NPT is much more balanced than before.

A third aspect of the problem in connection with NPT safeguards was the global nature required for such safeguards by the NPT. NPT safeguards were rightfully expected to be universal. They should embrace political parties that are not within the same political grouping. Up to then safeguards had been executed only within such political groupings and not across.

This made it obvious that the existing IAEA safeguards as described in INFCIRC/66 and its revisions were not designed to meet this new situation. A much more detailed description and design of safeguards was required to do this. Or more precisely, a much greater formalization was required. A strong formalization allows one to more safely predict what safeguards are up to. Further, it was necessary to make the whole safeguards procedures more objective. Not the subjective feelings of those who inspect, but objective findings that can be proven and demonstrated must be the basis for NPT safeguards. This then leads among other things to a predetermined answer to the question: when will the inspector be satisfied? Is he searching for a kilogramme, for 10 grammes, for a gramme or for a milligramme of nuclear material? This must be answered in advance so that the signatories of the NPT know what to expect. Finally, NPT safeguards must be rational. Otherwise it would be impossible to have truly global safeguards simply for financial reasons.

V. *Safeguards and the NPT*

One can summarize by saying that the universal nature of NPT safeguards requires such safeguards to be *formalized*, *objective* and *rational*. These were the considerations that led to the establishment of the principles for NPT safeguards. In the NPT (preamble and article III) this principle is described as follows:

> the principle of safeguarding effectively the flow of source and special fissionable materials by the use of instruments and other techniques at certain strategic points. [4]

This description points to a technical situation. It is the flow of nuclear material through the fuel cycle. In the commercial application of nuclear energy many thousands MW(th) are produced and many kilogrammes per day are flowing through the cycle accordingly. The universal nature of NPT safeguards also covered all processes involved in the fuel cycle, that is, reactors, chemical reprocessing, fabrication, transport and storage. This is in contrast with the earlier situation of IAEA INFCIRC/66 where it was the isolated nuclear facility for which that early IAEA system was designed. The difference can be illustrated by examining the part of the fuel cycle that connects the reactor and the reprocessing plant. If one considers the reactor as an isolated facility it is necessary to calculate the build-up of plutonium in that reactor. This is a tedious and still insufficiently accurate job. If on the other hand the reactor is considered to be part of a fuel cycle, all one has to do is to make sure that the irradiated fuel elements reach the dissolver of the reprocessing plant. There the fuel is then open and accessible for direct measurement. Measurement becomes the most important tool in a modern safeguards system such as that of the NPT. This also helps to expedite the search for objectivity and formalization. Measurements result in figures and figures can be dealt with objectively, at least in principle, and the procedures can be formalized. It is now natural to consider instruments and other techniques that measure the flow through the fuel cycle. For that, certain points have to be identified. They then become strategic points. For instance, the dissolver of a reprocessing plant is obviously such a strategic point in the fuel cycle. On the other hand, most of a nuclear power station is not of interest for measuring the flow of material through the fuel cycle. It is therefore not necessary to expose most of such a power station to safeguards procedures. The IAEA has given a definition of a strategic point:

> Strategic point means a location selected during examination of design information where, under normal conditions and when combined with the information from all "strategic points" taken together the information necessary and sufficient for the implementation of safeguards measures is obtained and verified; a "strategic point" may include any location where key measurements related to material balance accountancy are made and where containment and surveillance measures are executed. [5]

The principle of NPT safeguards defines safeguards procedure in a predictable way as necessary and sufficient procedures. It thus also helps to make safeguards rational. The IAEA definition of a strategic point also makes explicit what the three principal components of NPT safeguards are: material balance accounting, containment and surveillance.

The containment which exists, in most cases anyway, provides a conduit function for the flow of nuclear material through the fuel cycle and surveillance helps to make the system complete where necessary. Storages may be a good example of that.

The NPT safeguards principle concentrates on the nuclear material. Indeed, it is the nuclear material that establishes the link between the civilian and the military domain. If the civilian domain could be made completely tight against the military domain the whole safeguards problem would be taken care of. Of course, the nuclear material has to be somewhere, mostly in nuclear facilities and to that extent NPT safeguards also touch the nuclear facilities. But the fact that NPT safeguards have as their subject the nuclear material and not the peaceful applications as such establishes a subtle but sometimes decisive distinction. It is then natural to have accountability of nuclear material as the main component of NPT safeguards. Surveillance, where required, makes the safeguards system complete.

The NPT safeguards principle brought new, mostly technical, substance into the procedure of negotiating the NPT. It was felt that the technical weight of such substance is large enough to resolve the above mentioned difficulties of NPT safeguards. In 1967 the IAEA started a whole sequence of working groups that brought together a limited but capable group of experts who worked hard to analyse the problem in greater depth and to spell out, in an iterative fashion, solutions to the various subproblems. This cautious and wise approach was in my judgement outstandingly successful. In the summer of 1970 it was possible to hold the first large international symposium on safeguards techniques at Karlsruhe, Germany. The Board of Governors of the IAEA established the Safeguards Committee that negotiated in great detail the procedures for NPT safeguards during the second half of 1970 and the early part of 1971. In spite of its large membership this committee was very successful. Its results are contained in IAEA Document INFCIRC/153 which has served as a base document ever since.

It was necessary to install various levels of safeguards. The INFCIRC/153 document distinguishes the level of the operator of a nuclear facility. The operator keeps certain predetermined records and forwards form sheets as reports to the safeguards authorities. Inspections are conducted by a national or regional safeguards authority and the IAEA verifies these procedures by making sure that the inspection of the national or regional safeguards authority is properly executed by a limited amount of inspections of its own. A certain structuring of the safeguards procedures was thus necessary in order to make the whole safeguards process feasible.

VI. *The NPT, the Treaty of Rome and the nuclear-weapon states*

From the outline given above it can be seen that safeguards procedures should be applied to the peaceful applications of nuclear energy regardless of whether the peaceful applications take place in nuclear-weapon states or in non-nuclear-weapon states. It is the principle of equality in the civilian domain that leads to this request. The whole approach and the provisions of the NPT can easily become a precedent for future non-proliferation problems. Therefore it is more than ever necessary not to let the idea of non-proliferation apply to the civilian domain. During the negotiations of the NPT this approach led the industrialized non-nuclear-weapon states to ask the nuclear-weapon states to apply NPT safeguards also to their peaceful applications of the atom. The USA and Great Britain basically agreed and made a formal offer to IAEA to do just this. In the case of France, which is not a signatory of the NPT, it was argued that France is a signatory of the Treaty of Rome and to that extent subject to Euratom safeguards. This throws additional light on the question of IAEA versus Euratom safeguards.

The sequence of events started in March 1970 when the NPT came into effect. The NPT requested the non-nuclear-weapon states adhering to the treaty to start their negotiations with the IAEA 180 days after the original entry into force of this treaty. This would have been September 1970. However, the Safeguards Committee of the Board of Governors of the IAEA revealed their results only in May 1971. The text of the NPT requests the conclusion of the negotiations between the IAEA and the non-nuclear signatory not more than 18 months later. This leads then to November 1972, at the latest, as the starting date for NPT safeguards to become operative. However, this schedule applies to those non-nuclear signatories for whom the NPT entered into force in March 1970. The Euratom non-nuclear weapon countries insisted on having the Euratom safeguards continue in a way that satisfied both NPT requirements and the provisions of the Treaty of Rome. In order to assure this they signed, but did not yet ratify, the NPT. This means that at least formally the clock has not yet started to run.

To give the desired assurance it was necessary to start negotiations between the IAEA and Euratom. This in turn required Euratom to have a mandate from the Council of Ministers but here the complex problem of the nuclear weapon status of France came up which took some time to resolve. The Treaty of Rome does not make a distinction between nuclear-weapon states and non-nuclear-weapon states but the NPT does. On the other hand, France is not a signatory of the NPT. It was possible to resolve that problem within Euratom by compromise and the negotiations between the IAEA and Euratom started. They were successfully concluded in March of this year. It was possible to reconcile the Treaty of Rome and the NPT. If, on a *de facto* basis, safeguards in the Euratom countries were in the past a cross between the Treaty of Rome and the US Atomic Energy Act of 1954 they will probably, in the future, be a cross between the Treaty of Rome and the NPT.

It is reasonable to expect ratification of the NPT by the non-nuclear-weapon states of the European Community in the course of 1973: NPT safeguards can then become effective in turn. One should realize that even this way one arrives at November of 1973, the date that was calculated above as the latest date to make NPT safeguards effective for those signatories that had ratified early. The accumulation of practical NPT safeguards experience in larger amounts therefore might actually start in 1974. In my judgement it will take two or three years after that before a review of existing NPT safeguards experience can be meaningful. The text of article VIII of the NPT, however, provides for a first review conference five years after entry into force of the NPT, that is, in 1975. In view of the very elaborate work that went into the preparation and build-up of NPT safeguards and in view of the size and complexity of the matter, only a thorough evaluation of a sufficient amount of practical field and headquarter experiences makes sense, in my judgement. I therefore express the personal view that a first review conference in 1975 is definitely too early so far as the problem of safeguards is concerned.

VII. *Physical protection*

There is one more point that must be dealt with. The Safeguards Committee of the IAEA Board of Governors has made it explicit that IAEA Safeguards are aimed at the early detection of a diversion of nuclear material. Paragraph 28 of INFCIRC/153 reads accordingly:

> . . . The objective of safeguards is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection. [6]

Earlier in this chapter we dealt with the fact that it is nuclear material that is subject to safeguards and not the peaceful applications as such. Paragraph 28 also says that it must be a significant quantity. That means that not each individual milligramme as such can be subject to safeguards but it also says that timely detection is the objective. It is the concern that a state could be going nuclear. It was not the single accident but rather the planned long-range preparation of a government for the production of nuclear weapons that was at stake when the NPT was designed. It is only consistent then that the IAEA deals officially only with governments, not with individuals. It is the government of a signatory state that undergoes the obligation of NPT safeguards and all the legal steps required to do this are imposed on the operator of a nuclear facility by its government, not the IAEA. By comparison, Euratom deals directly with the operator. The signatories of the Treaty of Rome have impowered Euratom with the necessary sovereign rights.

But let us go further. Paragraph 28 says that deterrence of such division is also aimed at. The logical extention of deterrence is prevention. On the level of a state this deterrence might be expected to work in many cases although certainly not in all cases. The sequence: detection, deterrence, prevention leads then naturally to physical protection.

Physical protection is not the explicit objective of NPT safeguards. One has to realize however that much of the protection can be covered by safeguards that are aimed at detection. Apart from material accountancy and surveillance, it is the measure of containment that makes up for the three principle components of safeguards. This is the case at least for most of the large power reactors. It is natural therefore that the IAEA has recently issued "Recommendation for the Physical Protection of Nuclear Material". [7] These recommendations were published in June 1972 and the IAEA gives these recommendations to the governments. This is consistent with the fact that physical protection is in practically all cases aimed at individuals or groups. Following an article of Ralph Lapp [8] let us call such a group "group X". The problem of group X is not within the scope of the NPT. The basic feature of the NPT is the distinction between nuclear-weapon

Table 1. Physical protection of nuclear material

Possesser of material	Detection of diversion	Protection against diversion
State	Taken care of by NPT and other safeguards	Mostly taken care of by NPT and other safeguards (de facto)
Group X	Taken care of by NPT and other safeguards	Open

states and non-nuclear-weapon states and it is obvious that this distinction cannot be made for the problem of group X. Group X can operate in all countries regardless of whether they are nuclear-weapon states or not. Any international arrangement that may be envisaged must therefore cover all states equally. It may be helpful to summarize that situation as is done in table 1. above.

VIII. *The context of the NPT and future tendencies*

The final section of this chapter will deal with the context of the NPT. The fact is often overlooked that there are today as many as eight treaties that may be called non-proliferation treaties. [9]

The Antarctic Treaty of 1959

This treaty is aimed at the non-proliferation of military activities into the Antarctic. It contains provisions for inspections. But it also contains provisions that we would today call environmental or ecological provisions.

The Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (1963)

This treaty is aimed at keeping the atmosphere, outer space and under water clean and "to put an end to the contamination of man's environment by radioactive substances".

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies (1967)

This treaty is designed to avoid the proliferation of military activities into outer space. It contains provisions that one could call environmental provisions, that is to keep the outer space clean. It also contains a provision that can be interpreted as belonging to the safeguards domain.

4. Arguments for extended NPT safeguards

J. PRAWITZ[1]

Abstract

Developments in the implementation of safeguards and the growth of the nuclear industry provide the basis for a discussion of what improvements and amendments could be proposed at the NPT Review Conference to be held in Geneva in 1975. This chapter discusses the possibility of extending the application of IAEA safeguards as opposed to the agreed provisions of the 1968 non-proliferation treaty. Nuclear activities left uncovered by the compromise in the treaty as well as new safeguard needs are analysed and the need for additional measures of physical security is pointed out. The necessity of treating weapon-grade plutonium in the same manner as reactor-grade plutonium and plutonium in the same manner as uranium is also disucussed. A maximum proposal regarding the strengthening of the NPT concludes the chapter.

I. *Introduction*

When the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was negotiated in the mid-1960s, the question of safeguards was always considered an important and difficult one. In August 1967 it moved into the focus of world politics when the USA and the Soviet Union put forward identical draft treaty texts with blank space left for the control article. This left safeguards as the only issue separating them from complete agreement. Half a year later, compromise language was proposed and on 12 June 1968 the General Assembly of the United Nations passed the NPT. [1] It is natural that the resulting control article could not take into account all wishes and suggestions expressed. However, the article was accepted and became the basis for the implementation of control. Detailed principles of such implementation were later worked out by the International Atomic Energy Agency (IAEA) in IAEA document INFCIRC/153 (the Blue Book) [2] and a number of bilateral safeguards agreements were concluded between the agency and individual NPT parties as prescribed in the treaty.

This process has by now produced a certain amount of experience. In

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[1] The views and opinions expressed in this paper are those of the author and do not imply the expression of any position on the part of the Swedish Ministry of Defence.

J. Prawitz. Arguments for extended NPT safeguards. In Nuclear Proliferation Problems. c1974. pp. 158-167. Reprinted with permission, Stockholm International Peace Research Institute.

addition, the continued negotiations to stop the nuclear arms race (SALT) can be expected to create some inspiration for further strengthening the NPT. Moreover, the growth of the civil nuclear industry and the expected build-up of plutonium stockpiles are easier to assess today than they were five years ago. However, it is also apparent that a number of important states have not become parties to the NPT and will not become parties in the near future. The possibility that weapon-grade nuclear material would be stolen by terrorists and guerillas for blackmail purposes was not taken seriously in 1968 but is now considered a reality. These developments provide the basis for a discussion of what improvements and amendments could be proposed at the Review Conference to be held in Geneva in 1975 in accordance with NPT article VIII.3.

Possible amendments to the NPT can be divided into two political categories. One includes issues which were discussed before the NPT agreement in 1968 and which might be raised again at the Review Conference. The other category includes new issues not discussed at that time, such as protection of plutonium against theft by terrorists. In the latter case some measures will probably be of interest to all governments and successful negotiations may be possible in a reasonable time. However, in the former case it might be much more difficult to change old compromises and rehash past issues.

II. *The scope of the present provisions*

The NPT introduces safeguards in two ways: first by stipulating that non-nuclear-weapon states, parties to the treaty, apply safeguards on "all (its) source or special nuclear material in all peaceful nuclear activities" and secondly by stating that all parties to the treaty should not provide, except under safeguards, nuclear material and certain other specified equipment and material to any non-nuclear-weapon state, whether a party to the treaty or not.

This latter provision, enforcing some arms control on nonsignatories who import nuclear material and equipment from states party to the treaty, together with corresponding provisions in treaty articles I and II makes the NPT an international scheme for cooperative prevention of proliferation rather than a treaty for individual abstentions from the nuclear option. The behaviour of nonsignatories will of course be of fundamental importance from the point of view of non-proliferation; therefore, the possibility of influencing them in this respect is very important. This approach might also be politically realistic because there seems to be a deep and general consensus among all states, (including those who hesitate to subscribe to the treaty themselves) that non-proliferation is good for others.

Safeguards will thus apply to all peaceful nuclear activity in non-nuclear-weapon states, parties to the treaty, and to such nuclear activity in non-signatory non-nuclear-weapon states, that is connected with imports from signatory states.

Uncovered by safeguards will be the remaining peaceful nuclear activities in nonsignatory states, all nuclear activities in nuclear-weapon states, and all nonpeaceful nuclear activities other than bomb-making in non-nuclear-weapon states.

III. *Possible voluntary application of safeguards*

Due to unilateral undertakings and requests by suppliers, there might be an additional area covered by safeguards in nuclear-weapon states and in nonsignatory countries. For example, the United States has announced that when the NPT comes into force, IAEA safeguards will be applied to all its nuclear activities, excluding only those with direct national security significance. [3] Great Britain has made the same offer in relation to its nuclear activities. [4]

It is also reasonable to assume that many non-nuclear-weapon states, on an individual basis, wish not to be connected with any actual or potential nuclear weapon programme, and, therefore, may include a provision in their individual safeguards agreements for the "continuation of safeguard" with respect to nuclear material transferred out of the country.[2] Such a provision would assure that all nuclear material transferred from the country and any subsequent generation of special fissile material derived from such transferred materials would never support any nuclear weapon production.

This would be specifically true in three cases not covered by the NPT; namely, material transferred to a nuclear-weapon state, to a nonsignatory non-nuclear-weapon state after passing through a nonsignatory nuclear-weapon state and to a signatory non-nuclear-weapon state that withdraws from the non-proliferation treaty and terminates the related safeguards agreement when the material is present there.

IV. *Military non-nuclear weapon activities*

As safeguards, according to the NPT, shall apply to nuclear activities for *peaceful purposes* only and as the manufacture of nuclear weapons and other nuclear explosive devices is the only use of fissile materials which the treaty forbids a non-nuclear-weapon country, there will be a category of uses for such material which is not forbidden but which a state might declare nonpeaceful and which, therefore, could be exempted from safeguards. One example of such use is fuelling reactors for the propulsion of submarines, aircraft carriers and other naval vessels. In general, this category would include all material used or intended for use in any nuclear activity that is not the manufacture of explosive devices but is declared to be nonpeaceful, or material intended for export to nuclear-weapon countries for any nonpeaceful purpose.

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[2] Basic provisions for the continuation of safeguards are laid down in the IAEA statute article XII.A.5 and in the IAEA Safeguards System (1967). [5]

It is clear that the NPT control machinery would lose a great deal of its significance if such permitted activities, which might also include handling of weapon-grade materials, are left free of control. The existence of this independent nuclear area in signatory states could quickly violate the aim of the non-proliferation treaty. Therefore, it is encouraging that the safeguards agreements prescribed by the NPT will put certain restrictions on the possibilities of exempting material from control.[3]

V. *Hidden facilities*

According to Blue Book paragraph 62, parties shall provide the agency "with an initial report on all nuclear material which is to be subject to safeguards". This applies both to material used for peaceful (NPT article III.1) and nonpeaceful (Blue Book paragraph 14) purposes. However, to verify that *all* material has really been declared poses a problem, as the IAEA is not able to scan a country for material and facilities which may not have been declared.

This dilemma was solved in articles 11–18 of the Treaty for the Prohibition of Nuclear Weapons in Latin America (the Tlatelolco Treaty) by means of a special agency to carry out "special inspections", if a party to the treaty were to make reasoned requests for such inspections. How this would be done in practice has not yet been worked out. One suggestion is that if one party suspected that a specific unsafeguarded installation or building on the territory of another party was of the kind that should have

[3] These restrictions are outlined in the Blue Book, paragraph 14 which prescribes that a state wanting an exemption from safeguards on nuclear material for a permitted nonpeaceful purpose shall inform the agency of the activity, making it clear "that the use of the nuclear material in a non-proscribed military activity will not be in conflict with an undertaking the State may have given and in respect of which Agency safeguards apply and that during the period of non-application of safeguards the nuclear material will not be used for the production of nuclear weapons or other nuclear explosive devices". The state and the agency shall in addition make an arrangement so that, only while the nuclear material is used in such an activity, will the safeguards provided for in the agreement not be applied. The safeguards provided for in the agreement shall apply again as soon as the nuclear material is re-introduced into a peaceful nuclear activity. The agency shall be kept informed of the total quantity and composition of such unsafeguarded nuclear material in the state of any exports of such material. Each arrangement shall be made in agreement with the agency.

been declared for control, the regional agency mentioned could invite the IAEA to go to the place and carry out a special inspection.

VI. *Physical security*

It should be appreciated that the IAEA safeguards system is only a fact-finding machine. There is nothing prohibiting a country from sending home the inspectors and using safeguarded materials for bombs. Safeguards will detect but not prevent that. There is also the possibility that weapon-grade material could be stolen by subnational terrorist and guerilla groups for blackmail purposes or by agents of other states. The present wave of hijacking and terrorism must not escalate to the nuclear level. However, many of the bilateral agreements for nuclear material supply already stipulate rules intended to improve the physical security of safeguarded material. The main ones are:

1. An option can be made for buying back plutonium produced with the supplied fuel if it is not needed by the consumer, provided that the plutonium not being utilized in reactors be located in storage facilities designated by the supplier. Although there are economic reasons for this policy, the main purpose is to stockpile surplus plutonium in the most secure places from the supplier's point of view. In addition, the IAEA[4] statute and the Euratom treaty[5] provide for distributed stockpiling of special fissionable material.
2. Supplier nations also frequently reserve a right to pre-approval of any reprocessing of supplied fuel. The purpose of this provision is to avoid the use of facilities where accounting for extracted plutonium is difficult and, consequently, diversion easy.
3. A request can also be made for specifications of any project involved before fuel delivery is approved.
4. As a consequence of provision 3, the right is reserved to approve beforehand any resale of supplied fuel and equipment to third countries. The prime purpose of this is to get assurance that reactors using supplied fuel are power, and not dual purpose or plutonium production, reactors.

[4] The relevant provision is included in article XII.A.5 of the IAEA statute, which makes it possible to "deposit with the Agency of any excess of any special fissionable materials recovered or produced as a by-product over what is needed in order to prevent stock-piling of these materials, provided that thereafter at the request of the member or members concerned, special fissionable materials so deposited with the Agency shall be returned promptly to the member or members concerned for use" as may be permitted.

[5] Article 80 of the Euratom treaty prescribes that the Euratom Commission "may require that any excess of any special fissionable materials recovered or produced as a by-product, not being actually in use or ready for use, be deposited with (its) Agency or in storage premises which are or can be controlled by the Commission. The special fissionable materials so deposited shall, at the request of the parties concerned, be returned to them without delay".

5. Shipment schedules can be restricted in order to avoid unnecessary stockpiling of nuclear fuel awaiting use in reactors.

6. Most countries apply general and strict secrecy to certain technical information and know-how, mainly concerning design of nuclear explosive devices and methods for separation of uranium isotopes.

It has also been claimed that some suppliers have sold fuel and equipment cheaper than the production costs in order to spread the application of safeguards. Most supplier nations exercise some or all of the abovementioned policies.

Some of these provisions will be obsolete when the IAEA safeguards system comes into full operation. The Blue Book provides for design information (paragraphs 8, 42–48) but a system for dispersed stockpiling would probably be very desirable to reduce the risk that fissionable material would be used in contradiction with international agreements. Buying-back plutonium may cause small countries with large uranium deposits great financial problems if they are going to buy all the plutonium that happens to be produced with the uranium they export. Clearly, an international scheme for administration of plutonium flows and dispersed stockpiling would be very helpful, at least for small suppliers, in the same way as the IAEA safeguards system is helpful for countries not having the necessary resources to organize a worldwide network of bilateral safeguards to watch exported material.

The selection of places where plutonium deposits can be optimally guarded introduces a dilemma: which organization is strong enough to protect the stockpiles effectively and at the same time is unable itself to seize the stockpiled material? Particularly sensitive from a security point of view is transportation of nuclear materials both between countries and within countries. Guarding material in stock and in transit may possibly be a task for a special UN or IAEA guard force. The problems of physical security to protect fissionable material from diversion by governments require especially careful study.

A different problem is to protect stockpiles from unauthorized use by individuals and groups. That would be the responsibility of governments and it is a question of physical security in its real sense. Practical measures to protect nuclear material in use, storage and transit were recommended by the IAEA in June 1972 (the Grey Book).[6] A binding international commitment to apply such measures would reduce the general risk for diversion of material. Recognizing the possible dimensions of the effects of such diversions, an international agreement to prevent them seems adequate, while the practical management of relevant measures could be a task for national governments.

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[6] While these "Recommendations for the Physical Protection of Nuclear Material", produced by a panel of experts working under IAEA sponsorship in Vienna from 6–10 March 1972, "are not binding upon States, they represent the conclusions of the experts for an optimized system and they are recommended for use by States as required in their physical protection systems".

VII. *The plutonium-240 problem*

According to paragraphs 79–80 and 104 of the blue book, the inspection intensity at a certain nuclear facility would be related to the number of effective kilogrammes of nuclear material in that facility. This concept focuses more attention on highly enriched uranium than on the same amount of a lower grade material. No similar discount is envisaged for reactor-grade plutonium containing a higher concentration of the isotope 240 as compared to weapon-grade qualities containing only a few percent.

From time to time it has been suggested that plutonium should be treated in the same manner as uranium, which would considerably reduce the burden of safeguards in the future. This idea has consistently been resisted by representatives of the nuclear powers without explanation and qualifications due to the secrecy applied to nuclear weapon technology. The credibility of similar statements from representatives of non-nuclear powers is of course less.[7]

A suggestion, made at a scientific symposium in 1970 by this author, that it would be possible to produce a nuclear explosion from essentially any grade of reactor-produced plutonium was then confirmed in the written statement of an experienced Los Alamos scientist.[8]

In a recent public statement [8] the Swedish scientist Dr Nils Gyldén said that use of reactor-grade plutonium for bombs may give a yield that is lower and more difficult to predict, but it would probably give a yield of nuclear size. The higher the Pu-240 concentration, the less predictable the yield. For a sophisticated military purpose, weapon-grade plutonium would be necessary. For demonstration purposes, reactor-grade material may very well do and that is the essential fact with respect to the NPT.[9]

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[7] An early discussion of this problem took place in the so-called Randers committee in 1964. [6]

[8] Dr C. J. Mark said in a lecture at the 10th Pugwash symposium in Racine, Wisconsin, 26–29 June 1970, "I should like to mention a comment of Dr Prawitz of the National Research Institute of Defence in Stockholm to the effect that a colleague of his has become persuaded that he could produce a nuclear explosion from essentially any grade of reactor-produced plutonium that might be available. I am not familiar with the details of the calculations of Dr Prawitz's colleague, and I can only assume that by "nuclear explosion" he means what I would mean, which is an explosion of at least three orders of magnitude more energy per pound than would be available from high explosives. From my own considerations of this problem, I have no reason to question such a conclusion, and I would like to warn people concerned with such problems that the old notion that reactor-grade plutonium is incapable of producing nuclear explosions—or that plutonium could easily be rendered harmless by the addition of modest amounts of the isotope Pu-240, or "denatured" as the phrase used to go—that these notions have been dangerously exaggerated." [5]

An independent study by the Finnish phycisists P. Jauho and J. Virtamo arrived at the conclusion that even in the "worst" case, a device using heavily Pu-240-contaminated fuel, the explosion yield may range up to one kiloton. [10] This problem is also discussed by Professor J. K. Miettinen and Dr John Hopkins in their respective chapters.

VIII. *A maximum proposal*

In order to strengthen the NPT several measures extending the safeguards procedure may be envisaged. These extended safeguards may also require a matching extension of the scope of NPT articles I and II.

One such measure might be the prohibition of any party of the NPT from assisting any other country in acquiring nuclear weapons. At present the nuclear countries are forbidden to transfer nuclear weapons to any recipient whatsoever and to assist non-nuclear states in acquiring nuclear weapons, while they are permitted to assist each other. In addition, non-nuclear-weapon states are not formally prohibited from assisting other countries who want to make the bomb. These possibilities could be closed by means of amending treaty articles I and II.[10]

Most nuclear powers, and indeed the USA and the USSR, do not co-operate with each other in the field of nuclear weapon design. Only the USA and Britain have a special relationship in this respect, and it was to provide for the continuation of that relationship that cooperation between nuclear powers was permitted in article I of the treaty. The prohibition of that relationship is not desirable but if the political integration of Western Europe could reach the point where a country could inherit both the nuclear power status of France and Britain and the special relationship between Britain and the USA it would constitute an opportunity for rapid proliferation. Moreover, that country would become the greatest single new nuclear power that could be envisaged.

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[9] The views of Dr Gyldén were confirmed in an authoritative statement by the Swedish Research Institute for National Defence (FOA) on 25 June 1973. [9]

[10] Articles I and II may be amended to reflect the suggested ban on all cooperation in nuclear weapon technology between all states in the following way:

I. Each State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons and other nuclear explosive devices directly or indirectly; and not in any way to assist, encourage, or induce any other State to manufacture or otherwise acquire nuclear weapons, or other nuclear explosive devices, or control over such weapons or explosive devices.

II.a. Each State Party to the Treaty undertakes not to seek or receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or the control over such weapons or explosive devices directly or indirectly; or any assistance in the manufacture of nuclear weapons or other nuclear explosive devices;

b. Each non-nuclear weapon State Party to the Treaty undertakes not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices.

As time goes on and the understanding and potential capability of weapon making spreads, measures to stop cooperation in nuclear weapon technology between countries that are now non-nuclear will become more urgent. A loophole in article II was discovered by the United Arab Republic delegation in Geneva before the treaty was concluded but it was not removed for procedural reasons. There are authoritative statements to the effect that this loophole should not be considered to exist but its formal closing would be preferable.[11]

It would also seem necessary to remove the possibility of exempting nuclear material used for nonpeaceful purposes. Safeguards should apply to all nuclear material whatsoever in a non-nuclear-weapon state party to the treaty and the qualification "peaceful" in article III.1 should be deleted.

Furthermore, the safeguards clause should be amended to provide for "the continuation of safeguards" on all nuclear material transferred to and from a party. Nuclear-weapon states should also gradually start applying safeguards on their peaceful nuclear activities in addition to those covered by the transfer rule mentioned earlier. These measures would greatly improve the possibilities of accounting for the world stockpile of fissionable material and also provide certain arms control effects such as the suggested amendments to articles I and II.

In addition, the possibility should be explored of providing for special inspections, if requested by a party which suspects that some prohibited activity has been carried out in another state.

Finally, provisions for improved physical security should be added to article III. These may include obligations to use the services of the IAEA for dispersed stockpiling of excessive special fissionable material and to establish effective protection of material in stock and under transportation by special guards, possibly by the IAEA.

[11] On 26 September 1967, the United Arab Republic representative in the ENDC suggested that a special sentence should be added to the draft article II saying that non-nuclear-weapon states "should not in any way assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices". [11] However, the Soviet representative on 27 February 1968 argued that such an extra provision was unnecessary because it was already covered by "the meaning of Article II and the preamble to the Treaty. If a non-nuclear-weapon State Party to the Treaty were to assist another non-nuclear-weapon State to manufacture and acquire nuclear weapons, such a case would be regarded as a violation of the Treaty". [12] The US representative, on the same occasion, argued that "it seems clear that a non-nuclear-weapon State which accepts the Treaty's restrictions on itself would have no reason to assist another country not accepting the the same restrictions to gain advantage from this fact in the field of nuclear weapon development. If a non-nuclear-weapon Party did nevertheless attempt to provide such assistance in the territory of a non-party, the presumption would immediately arise that these acts had the purpose of developing nuclear weapons for itself, in violation of the Treaty". [13]

References

1. United Nations Document A/RES/2373 (XXII).
2. *The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, IAEA Document INFCIRC/153 (the Blue Book).
3. Document ENDC/206 5 December 1967.
4. Document ENDC/207 5 December 1967.
5. IAEA Document INFCIRC/66/Rev. 1, section 16, 1967.
6. IAEA Document GOV/COM. 14/OR. 6–7.
7. Mark, C. J., "Nuclear Weapons Technology", in Feld, B. T. *et al.*, ed., *Impact of New Technologies on the Arms Race* (Cambridge, Mass., MIT Press, 1971) p. 137.
8. *Dagens Nyheter*, 15 May 1973.
9. FOA 4 Dnr 4660-45.
10. Jauho, P. and Virtamo, J., "The Effect of Peaceful Use of Atomic Energy upon Nuclear Proliferation", Paper presented to the Helsinki Arms Control Seminar, June 1973.
11. Document ENDC/197.
12. Document ENDC/PV. 370, paragraph 59.
13. Document ENDC/PV. 370, paragraph 83.

2. The IAEA's NPT safeguards—national control and international safeguards

R. RAINER AND B. SANDERS

Abstract

The safeguards system applied by the IAEA pursuant to article III.1 of the NPT includes the new concept of a relationship between national control and international safeguards. It provides for the establishment of national systems of accounting and control of nuclear material. The IAEA will make full use of such systems in carrying out its verification activities and it will take account of the efficiency of the state's system in determining its inspection effort. The precise relationship between the national system and agency safeguards, and the degree of coordination between control activities of the state and of the IAEA, depend on many factors. Arrangements for coordination in the application of safeguards are part of the NPT agreement between the IAEA, Euratom and the latter's non-nuclear-weapon state members. Some technical elements of these arrangements might be relevant to agreements with individual states that have technically developed national systems, including national inspections. The coordination between international and national inspections might also be a useful precendent to follow in verifying arms control measures.

The IAEA's present safeguards operations are based on two principal legal instruments which in turn find their main support in the IAEA statute. The first instrument was the agency's Safeguards System 1965 (which was extended in 1966 and 1968) and, since 1970, there has been a system that was devised to define the agency's safeguards activities pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

The objective of safeguards under the Safeguards System 1965, in the terms laid down in the agency's statute, was to "ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further a military purpose".[1] The only limitation to this responsibility lies in the phrase "so far as it is

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[1] Article III.A.5 of the statute also authorizes the agency "to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangements, or at the request of a State, to any of that State's activities in the field of atomic energy". Article XII lists the safeguards, rights and responsibilities which the agency is to have to the extent relevant to the project or arrangement.

B. Rainer and B. Sanders. The IAEA's NPT safeguards--national control and international safeguards. In Nuclear Proliferation Problems. c1974. pp. 133-141. Reprinted with permission, Stockholm International Peace Research Institute.

able". Taken literally, this might be read to mean that the agency should make absolutely certain, by all means at its disposal, that none of the items under its safeguards are used, even indirectly, in a way that would further any military purpose. It is relevant to note that the safeguards operations that are governed by the Safeguards System 1965 still constitute the largest share of the agency's safeguards work, being applied at present in 27 out of a total of 41 states where the agency has safeguards responsibilities. It is evidence of the excessive scope of this objective and of the inability to define within that scope exactly what it is that the agency should do, that in reporting to governments on the outcome of its operations, the agency has so far had to limit itself to a statement that its inspections had not divulged a violation of the relevant agreement.

It was the experience the agency gained in applying its safeguards under the original system that prompted the drafters of the NPT to choose the agency as the instrument for applying safeguards under that treaty. When the NPT entered into force, however, steps had to be taken to adapt the agency's safeguards system to NPT conditions, particularly in view of the open-ended character of the 1965 system. Shortly after the entry into force of the NPT, on 5 March 1970, the agency's Board of Governors set up a committee to advise it on the agency's responsibilities in relation to safeguards covered by article III.1 of the NPT[2] and, in particular, on the content of the agreements to be concluded pursuant to that treaty. The committee met for almost a year and, at the end, recommended to the board a series of provisions that together form our present document INFCIRC/153, the so-called Blue Book. On the technical side, this was based on conceptual studies made by consultants, recommendations by panels and expert working groups and results from development and systems studies in member states of the agency. On the nontechnical side, model agreements were worked out. All this material was incorporated into working papers which were considered by the committee and which resulted in the Blue Book. One of the main results of this concerted action was a more precise definition of the objective of agency safeguards when used for the purpose of the NPT. This was formulated as

> the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices for purposes unknown, and deterrence of such diversion by the risk of early detection.

According to document INFCIRC/153 this objective could be achieved by the use of material accountancy as the safeguards measure of fundamental importance, with containment and surveillance as important supplementary measures. The document further provides that the technical conclusion of the agency's verification activities shall be a statement.

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[2] The board only considered safeguards requirements arising from article III.1 of the NPT. The question of safeguards requirements under article III.2 of the NPT was not dealt with by the board and is not considered in this chapter.

> . . . of the amount of material unaccounted for over a specific period . . . Furthermore, the sanctions provided in the Agency's Statute can now be called forth . . . if the Board upon examination of relevant information . . . finds that the Agency is *not* able to verify that there has been no diversion of nuclear material required to be safeguarded under the agreement to nuclear weapons or other nuclear explosive devices.

This new verification approach has introduced some new concepts into the safeguards philosophy. In this chapter the authors discuss one of the principal concepts involved, the interplay between national control and international safeguards.

The Blue Book provides that:

> The Agreement should provide that the State shall establish and maintain a system of accounting for and control of all nuclear material subject to safeguards under the Agreement, and that such safeguards shall be applied in such a manner as to enable the Agency to verify, in ascertaining that there has been no diversion of nuclear material from peaceful uses to nuclear weapons or other nuclear explosive devices, findings of the State's system. The Agency's verification shall include, *inter alia*, independent measurements and observations conducted by the Agency in accordance with the procedures specified in Part II below. The Agency, in its verification, shall take due account of the technical effectiveness of the State's system.

In carrying out its verification activities, the agency is to make full use of the national system and should avoid unnecessary duplication of the state's accounting and control activities. Some elements of the national system are described in the Blue Book. They include, for example, a system for measuring quantities of nuclear material together with a system for evaluating the precision and accuracy of measurements; procedures for inventory taking and evaluation of accumulations of unmeasured inventory and losses; a records and reports system, and measures to ensure that the accounting procedures are operated correctly. How far some of the actions listed are fulfilled by the plant operator, or, in some cases, by the state itself, naturally depends to a large extent on the specific situation in the country. Summarizing, one might say that the national system of accounting for and control of nuclear material should serve as the infrastructure for the application of the international safeguards system.

The 1965 agency safeguards system did not specifically assign a role to the national system. It was necessary, of course, for each state which had concluded a safeguards agreement with the agency to establish the internal machinery needed to meet its international obligations; however, there were no specific requirements for the organization of the system, and its components and operation were, consequently, determined exclusively by the state. Conversely, the agency's system operated to a large extent independent of the state's system and the intensity of agency safeguards and, in particular, the agency's inspection effort—which under the new system is influenced by the effectiveness of the national system and the quality of its findings—had no formal relationship with any activities of the state. The formal statement that there should be a national control system and the definition of its role within the international system has only been developed as part of the NPT safeguards system.

Discussion of this interesting concept of a control system to ensure compliance with treaty obligations, consisting of national measures brought into relationship with international safeguards, may be of substantial relevance for the future development of nuclear safeguards. One consequence of applying this concept might be a possible decrease in specific safeguards costs for the agency. It is becoming more important, given the continuous increase in nuclear activities and, therefore, safeguards work, that the agency ensure optimum cost effectiveness.

The definition of the technical objective of safeguards in the Blue Book has been an important step in dissipating possible apprehensions about the potential open-endedness of international safeguards. The development of effective national control systems and their systematic coordination with international safeguards will help to assure accomplishment of the technical objectives within the constraints governing the international system.

The Blue Book defines the relationship between the national system and agency safeguards in a flexible manner. It is also clear from the Blue Book that in verifying the findings of the national system, the agency not only checks the measurements and observations made by the state, but also makes its own independent measurements and observations. The magnitude of the independent activity is related, *inter alia*, to the uncertainties in the findings of the state's system. The Blue Book postulated a common objective for the national system and for the agency's safeguards. A formal (quantified) statement setting forth the technical conclusion is only required for the agency's verification acitivities. This should be a statement, within each material balance area, of the amount of nuclear material unaccounted for over a specific period and the limits of accuracy of the amounts stated.

Besides providing the basis for the application of agency safeguards, the national system has the task of guarding against diversion of nuclear material at the subnational level (that is, by individuals, groups or even by the operator himself). Appropriate measures by the state to ensure the physical security of nuclear material will be a desirable and necessary supplement to the three safeguards measures: nuclear material accountancy, surveillance and containment. Primarily, however, the national system should ensure that the required accounting data are available as records, open to inspection by the agency and transmitted to the agency in the form of reports. Also, the national system should evaluate these data, together with accumulations of unmeasured inventory and unmeasured losses. The Blue Book does not specifically require a state to establish a full-fledged inspection apparatus. For a state to do so, it must consider the nature and size of the nuclear activities on its territory and the concomitant degree of complexity of its accounting and control measures. The existence of national inspection reflects the efficiency of the national system and the extent to which the operators of facilities are functionally independent of the state's control system, a factor which the agency has to take into account in the determination of its own inspection effort. However, the task of national inspectors (who may have other functions besides those specifically connected with the application of a safeguards agreement) and their method of work may well differ from those of agency inspectors; consequently, to coordinate the two, special arrangements will be required.

There is yet insufficient experience regarding the extent to which a national system can be integrated into international safeguards work. The protocol to the NPT agreement signed on 5 April 1973 by the agency, the European Atomic Energy Community (Euratom) and the non-nuclear-weapon states, members of Euratom, contains specific provisions on the coordination of the safeguards activities of both organizations. Although these were developed in a different situation, some of the technical elements of the agreed coordination may also be relevant for the relationship between a highly-developed national system and agency safeguards. The major difference between the Euratom system and individual national control systems is the very high degree of functional independence of plant operators from the Euratom Commission. This may not exist elsewhere between operators and the national authority. The commission, as the authority for implementing the security control provisions of the Euratom treaty, is independent from the governments of member states in carrying out this task; accounting and other data are collected directly from plant operators. In addition, Euratom has a safeguards objective comparable to that of the agency. These particular aspects have to be fully recognized. As discussed below, some of the technical procedures agreed upon may equally apply to the coordination of a national system with the agency's system, provided a number of criteria are met by the national system.

The agency's NPT safeguards system—and, therefore, also the arrangements with Euratom—comprises the traditional components of the 1965 system (review of design information of plants, the requirement to maintain records on nuclear material, the obligation to transmit reports to the agency and the carrying out of inspections by the agency). The design information is used to prepare the technical document setting forth in detail how safeguards are applied at a particular plant (this is the so-called facility attachment which forms part of the Subsidiary Arrangements to the Safeguards Agreement). The collaboration in the evaluation of design information provided for reflects existing practice; subsidiary arrangements are always negotiated between the agency and the state. In the field of nuclear material accounting, a state may choose to establish a central nuclear material accounting system which would involve analysis and evaluation of the data received from nuclear plants. An evaluation by the state of these accounting data, involving also investigations of random and systematic measurement errors, or enquiries into causes of nuclear material unaccounted for, would considerably facilitate the verification task of the agency.

The nub of any coordination arranged between the IAEA and the state would lie in the national system's criteria and procedures for the acceptance or rejection of the operator's measurements and the way these are verified by the international safeguards system. The accuracy is a function of the kind and quantity of the material involved in a given material balance area and the measurement capability associated with it. The design information should give the figures for throughput and inventory at the key measurement points together with the accuracy with which measurements can be carried out. This information would enable the national system of accountancy and control—if it wishes to go that far—to design a verification plan which would permit it to make a statement on the quantities of material unaccounted for and their limits of uncertainty. As the actual throughput and inventory change, the magnitude, scope and nature of the verification effort should be adjusted; this is an iterative process which must continue as long as the safeguards are applied and which probably should be renewed for each material balance period, that is, each period for which, after the physical inventory is taken, a material balance is struck. At the same time the national system would verify the actual performance of the measurements by the operator. This process of national verification is also a continuing one. The international safeguards authority in turn has the task of drawing its own technical conclusions on the material unaccounted for and on the limits of uncertainty, and for this purpose, it has to use the results of its independent measurements. To this end, it has at its disposal the entire range of safeguards procedures including: the analysis of design information and of the on-going operational process; the independent verification of the operator's accounting and operating records; the analysis of the reports made by the operator; the taking and analysing of samples; the observation of physical inventory-taking, and the use and verification of means of surveillance and containment. Whatever the extent to which the international authority makes use of the findings of the national system, it must, under any circumstance, receive full design information, accounting reports and the information obtained by the national system in the application of its inspection, if any. The nature, intensity and scope of the independent verification by the international system will obviously depend on the kind of technical process involved, the quality of the operator's measurements and his measurement methods, the level of control applied by the national system and the latter's capacity to make statements that are independent from those of the operator. Thus, the extent and nature of the international verification is always subject to variation and the way it dovetails with the national system must be continuously reviewed.

The most important point in the coordination of national control activities and international safeguards concerns the coordination of inspections. Article 80 of the Blue Book states figures for the maximum routine inspection effort to be applied by the agency for categories of facilities, expressed in terms of man-years of inspection. There are no maxima for individual plants. Article 81 lists the criteria to be taken into account in determining the actual number, intensity, timing and mode of routine inspections of a plant; however, these criteria are neither susceptible to easy quantification nor does the Blue Book indicate the relative value to be assigned to each of them. Panels of experts have already achieved results in further defining these matters and in quantifying the technical conclusions to be reached in an iterative process. In the subsidiary arrangements there is usually a figure for the estimated actual routine inspection effort to be applied by the agency at a particular plant under normal conditions; for individual states these figures have had to be calculated without taking into account the impact national inspections may have once they are established.

Under the protocol to the IAEA/Euratom-NPT agreement, the estimates of the respective inspection efforts by Euratom and the agency for each nuclear plant will be worked out in advance according to agreed rules and methods. Similarly the verification approach and inspection procedures will be laid down in advance. The calculation of the inspection effort and the coordination of the inspection activities of the two organizations constituted the crucial part in the negotiations. The coordination arrangements, which take up 12 of the 25 articles of the protocol, involve:

1. A statement of principle that account will be taken of the community inspection effort in determining the actual number, intensity, duration, timing and mode of agency routine inspections.

2. Estimates of the actual routine inspection effort per facility will be agreed upon. These estimates are based on examples for specific types of facilities. (The examples are based on rules and methods for calculating routine inspection effort, agreed between Euratom and the agency.) These estimates will constitute actual maxima, subject to normal operating conditions and provided that a number of conditions continue to be met, such as: the continued validity of the information on community safeguards and of the design information provided; regular reports; application of the coordination arrangements for inspections, and the application by the community of its stipulated inspection effort.

3. Agency inspections will be carried out simultaneously with community inspections and the agency will implement its inspection rights by observing community inspection activities whenever it can so achieve the purposes of its routine inspections, as laid down in the agreement. This requires agree-

ment on planning and scheduling of inspections, on technical procedures, and advance coordination in the carrying out of each inspection. Equally, advance knowledge by the agency of the number, types and contents of the items to be inspected at a particular community inspection is necessary.

4. The agency must be fully informed of the work performed by community inspectors and on the results of community inspections; the "inspection working papers" for inspections at which agency inspectors were present and inspection reports for all other inspections have to be made available to the agency.

5. Techniques for random selection of statistical samples of nuclear material have to be agreed upon since samples for the agency are normally taken together with community samples.

6. An institutional machinery composed of representatives of the community and of the agency (liaison committee) is established to facilitate the application of the agreement and, in particular, of the coordination arrangements.

An analysis of these coordination arrangements shows that they are based predominantly on the existence of a technically effective and functionally independent control system (which will, in addition, be adapted to meet all the requirements resulting from the agreement, the protocol and the subsidiary arrangements) and on a willingness to undertake substantial additional obligations. It follows that certain elements of these arrangements could also be relevant to agreements with an individual state, provided that the state has a technically developed national system and is prepared to undertake substantial additional obligations in organizing and operating its national system, which, in turn, would enable the agency to take account of the national inspection effort.

The extent to which national inspections would be valuable in the context of an NPT-type agreement would depend on a number of factors. Among these are such considerations as: whether the national system is geared to obtain the same technical conclusions as the agency's system; the extent to which it provides for impartial and independent verification of operators' nuclear material accountancy; the adequacy of the quality control by the state of operators' measurement systems; the analysis of samples and checking of standards used for testing; whether the state's verification of physical inventories of nuclear material is compatible with agency requirements in both intensity and procedure, and whether the national inspection procedures meet agency standards. If these conditions were met, it should be possible to carry out national and agency inspections in such a way that the agency has full knowledge of the results obtained through national inspections and can use them for its own verification. All this would, obviously, require a very efficient (and possibly costly) national control system. The agency should, of course, always be in a position to carry out a substantial independent verification effort and to obtain a basic amount of data for itself. This implies that the agency should have direct access to all the information on which the national system bases its findings. If all these requirements were fulfilled, and appropriate coordination arrangements could be worked out, then the agency should be able to keep its routine inspection effort below the level at which it would have to perform otherwise, without this resulting in a lower credibility of the agency's statements on the results of its verification.

Safeguards consist basically of a bookkeeping system for nuclear material. As Dr Rometsch, the present head of the IAEA's Department of Safeguards and Inspection, put it in his paper for the 1971 Geneva Conference:

> That in practice bookkeeping can really be the backbone of a safeguards system is related to the simple fact that today's nuclear technology centers around the fission of the nuclei contained in only two chemical elements which are used almost exclusively for nuclear purposes—uranium and plutonium.

One has to examine very carefully, therefore, whether a comparable situation exists for other agreements in the field of arms control and whether there is a comparable relationship between the obligations to be verified and the proposed verification system. Nevertheless, it should be recognized that the NPT safeguards agreements assign for the first time a substantial role to national control measures; that they foresee a defined relationship of the international system with the national system in flexible terms, and that they have opened the possibility for the coordination of international inspection activities and national inspections.

Mason Willrich and Theodore B. Taylor
Nuclear theft: Risks and safeguards
(Excerpt)

Chapter Seven

Nuclear Safeguards: Basic Considerations

Thus far in this study we have examined the magnitude of the U.S. nuclear power industry and the potential risks of nuclear theft. We have also discussed the present AEC regulatory requirements designed to protect and account for nuclear materials, and observed that a safeguards system is not yet fully developed. Clearly, much remains to be done–and urgently–if an effective system of safeguards against nuclear theft is to be fully operational before very large amounts of fission explosive materials begin to flow through the U.S. nuclear power industry.

In this chapter we explore a number of basic issues related to the development of a nuclear safeguards system, including how effective such a system should be, and we also suggest a framework for the development of a variety of safeguard options. In chapters 8 and 9 we analyze specific safeguard measures and consider the costs of a safeguards system.

THE CONTEXT

We are concerned in this study with safeguards to ensure that nuclear material is not diverted from civilian industry to an illicit use. This particular objective should be viewed as part of regulating and controlling the civilian nuclear power industry in order to achieve several important purposes that are in the public interest. Aside from safeguards to prevent or detect theft, the control of nuclear material is necessary for two major reasons: to ensure that valuable materials are used efficiently as fuel for the generation of electric power or heat, and to ensure that radioactive materials that could endanger human health are used safely and are not inadvertently released to the environment in dangerous quantities or willfully dispersed by acts of sabotage. Controls designed to avert inefficient or unsafe use of nuclear material may either complement or conflict with safeguards to ensure against theft.

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For example, governmental material accountancy requirements may largely build upon inventory controls adopted by the plant management in the interest of efficient processing operations. As another example, both public health and safety and safeguards against theft point toward the use of specially developed heavy containers for the shipment of nuclear materials. However, plutonium that is shipped in the form of an oxide powder is less hazardous to public health, but slightly more of a bomb risk in the event of theft, than plutonium that is shipped in the form of a liquid nitrate solution.

PURPOSES OF A NUCLEAR SAFEGUARDS SYSTEM

Perhaps the most difficult task of all in developing and implementing a nuclear safeguards system is the formulation of meaningful objectives. It was relatively easy to develop an objective for the U.S. space program in the 1960s. President Kennedy did this in 1961 when he said: "We shall place man on the moon and bring him back to earth before the end of this decade." It is also possible to develop "full employment" as a continuing national goal and then to define a 4 or 5 percent level of unemployment as unsatisfactory performance. Though it is much more difficult for the United States to maintain full employment than to place a man on the moon, both objectives are meaningful to government, to industry, and to the man in the street.

When it comes to nuclear safeguards, what should be the objective of U.S. policy? We may initially and tentatively state the purpose of a nuclear safeguards systems as follows: *to provide effective assurance against acts of nuclear violence using material unlawfully obtained from the nuclear power industry*. When words are strung together in this way, the result is an opaque and abstract statement of the problem. However, it should be noted that many statements of purpose in legislation and administrative regulations are even more vague and less meaningful. For example, the legislative standard in the Atomic Energy Act for evaluating U.S. nuclear materials safeguards is that the controls must provide assurance against activities "inimical to the common defense and security or to the health and safety of the public." Nevertheless, our tentative formulation of purpose set forth above is useful as a point of departure.

We have avoided use of the word "goal" in our statement regarding safeguards because this word seems to imply the existence of some milestone which, if reached, signals the completion of a task. The risks of nuclear theft will persist in the foreseeable future, though it will be possible to reduce their likelihood and impact considerably. Consequently, the development and maintenance of effective safeguards will require continuing effort. Specific goals and objectives will probably have to be revised often in the light of advances in nuclear technology, growth of the nuclear industry, changes in the level and character of acts of violence (not necessarily nuclear), national and international political upheavals, and, perhaps above all, shifts in public attitudes towards violence.

This much having been said, in order to move further in our analysis we must grapple with the term "acts of nuclear violence," and with the term "effective assurance." In attempting to give more concrete meanings to such terms, we must distinguish the practical from the impractical, the obtainable from the unobtainable.

"Acts of nuclear violence" might encompass an infinite variety of circumstances ranging from hoaxes, to threats involving actual nuclear weapons, to actual fission explosions or intentional plutonium dispersal. At one extreme, it is impossible to provide assurance against the occurrence of nuclear threats that are hoaxes. As we saw in Chapter 6, all sorts of people could make a nuclear threat that is credible–at least up to some point–and still be a hoax. It is doubtful that any responsible government would completely ignore a nuclear bomb threat, much less publicly declare it to be a hoax simply because the threat was not substantiated by receipt of a nuclear explosive design or a small amount of fission explosive material. Threats using radiological weapons could be even more credible with minimal amounts of substantiating information. The real question, therefore, is whether a nuclear safeguards system can provide assurance that hoaxes can be distinguished from real threats, and that real threats would be most unlikely.

At the other extreme in the range of acts of nuclear violence are unannounced fission explosions in urban areas. Here again we must conclude, regrettably, that regardless of its effectiveness, a nuclear safeguards system applicable to the nuclear power industry in this country cannot provide complete assurance that unannounced fission explosions will not occur in the United States in the future. Apart from the fact that a foreign government might accidentally or intentionally explode a nuclear weapon in the United States, a fission explosive might be smuggled from a foreign country by a terrorist group and then detonated.

Furthermore, the possibility that a past, undetected theft is the source of a real nuclear threat cannot even now be discounted entirely. The amount of fission explosive material unaccounted for in the U.S. nuclear power industry and industrial enterprises performing work under contract for the AEC has already exceeded the point where complete assurance against bomb threats using diverted material is possible. Moreover, no future safeguards system that will be practical can offer 100 percent assurance against theft.

Then who is to decide, and on what basis, what level or risk of nuclear violence can or should be acceptable as a social cost of the use of nuclear energy to meet future needs for electric power? Is the explosive destruction or plutonium contamination of a large urban area somewhere in the world to be tolerated if it does not occur more than once a year? Once every fifty years? Never? These questions need to be addressed by political leaders, not professional experts. We do not presume to answer them in this study.

Very difficult issues also arise when we try to define "effective assurance" in our tentative statement of purpose of nuclear safeguards. Even if agreement could be reached concerning some maximum acceptable level of risk of nuclear violence using material stolen from the nuclear power industry, how *effective* should the assurance be that the specified thresholds of violence will not be exceeded? Who should decide, on what basis, what level of effectiveness is sufficient, given the fact that 100 percent assurance is impossible, no matter what we do? Perhaps a look at more familiar hazardous human activities can shed some light on these questions.

Are present highway, vehicle, and operator licensing safeguards against serious automobile accidents in the U.S. "effective?" The American people are apparently willing to tolerate more than 50,000 deaths per year as a result of automobile accidents, and many drivers still object to the cost or inconvenience of rudimentary safeguards, such as seat belts and shoulder straps. Measures that would reduce the highway death rate to, let us say, 500 people per year would probably be called *highly* effective, yet they would not lessen the grief of someone whose wife or husband or child was one of the 500 fatalities.

We accept a low commercial aircraft accident rate, and an even lower train accident rate, and delegate to experts the decision as to how safe our commercial aircraft or railroads should be. In these and other matters of public safety, the level of risk demanded by society as a whole, and even by individuals, is never zero. A combination of attention by safety experts, promotion by people who make a living from the hazardous activity, and public outcries when the risks begin to loom too large, tends to produce a level of risk that is generally accepted. Perhaps the acceptable level of effectiveness of nuclear safeguards could evolve in a similar way over time.

Before adopting this approach, however, several distinguishing factors should be taken into account. In transportation accidents the number of human casualties per crash, a few in the case of automobiles and one hundred or more in airplanes, is comprehensible. The frequency of accidents involving fatalities in relation to passenger-miles traveled can be determined. These statistics provide a basis whereby persons can make individual judgments concerning levels of risk involved in travel by a particular mode, and voluntarily decide whether the benefits to them are worth the risk.

When it comes to the risks associated with various levels of effectiveness of a nuclear safeguards system, tens of thousands of human beings may be killed in a single act of nuclear violence, and such acts will occur seldom at most and hopefully never. This leaves us with no basis for weighing the probabilities involved.

This seems to make it even more important for the people in a democratic society to have an opportunity to consent, in some way, to the risk of nuclear violence implicit in a particular level of effectiveness of safeguards. Such consent cannot be presumed from an absence of broad public concern when the man in the street remains unaware of the nature and scope of the risk to which he will be exposed. Nor can general public consent be inferred from broad legislative delegations of relevant authority to the AEC and the Joint Committee on Atomic Energy of the Congress, when public hearings on this specific nuclear risk have never been held, and when most members of Congress remain as uninformed in this respect as the people that elected them.

Finally, the problem of nuclear theft exists wherever nuclear power industries exist. A successful nuclear theft in one country may result in widespread destruction in another, far distant country a few weeks or several years later. Attitudes toward levels of risk and effectiveness of nuclear safeguards can be expected to cover at least as wide a range between countries as between groups within one country, such as the United States.

Given the difficulties discussed above, it seems that all attempts to develop a meaningful statement of overall goals for a nuclear safeguards system may well end in frustration. However, our discussion thus far does lead us to conclude as follows: In view of the seriousness of the risks arising out of a successful nuclear theft, the safeguards system applicable to the nuclear power industry should employ the *best available* technology and institutional mechanisms. The safeguards system should be developed and implemented with a view to keeping the risks of nuclear theft *as low as practicable.* We believe these statements can serve as a useful guide to the development and implementation of a nuclear safeguards system that will function effectively in a dynamic world in which technological, economic, social, and political factors are changing rapidly.

FUNCTIONS OF A NUCLEAR SAFEGUARDS SYSTEM

In order to provide effective assurance against acts of nuclear violence using material stolen from the nuclear power industry, a nuclear safeguards system as a whole should perform four interrelated functions:

1. prevention of theft;
2. detection of theft;
3. recovery of stolen material;
4. response to threats of nuclear violence.

"An ounce of prevention is worth a pound of cure." The relevance of this old saw to a nuclear safeguards system is apparent from the risk analysis in Chapter 6. Nevertheless, by far the most effort to date has been devoted to the development of means to *detect* unlawful diversion after it has happened. The detection method that has received the most attention until very recently has been accountancy—record keeping, inventory controls, reports, and independent audits. It should be noted that accountancy, unlike other possible methods of detecting diversion, such as continuous surveillance, makes little if any contribution to the related function of preventing theft.

Fortunately, the development of means to *prevent* theft is now receiving much greater attention. Such well known and widely used means as physical barriers, locks, alarms, etc., are being required. However, relatively little effort has been devoted either to the use of substantial manpower or to the development of more advanced technological methods for achieving physical security. This is in marked contrast to the efforts that have been devoted to various sophisticated techniques for the assay of nuclear materials, especially the non-destructive measurement of the material content of fuel elements, scrap storage drums, etc.–efforts which are related to the detection of theft after it has happened.

The need for means to *recover* material after it has been stolen is now officially recognized. Very little has been disclosed, about what, if anything, has been actually done to provide for recovery of stolen material or material that is simply lost. Similarly, little has been said about what happens if material is unaccounted for and the amounts involved exceed the allowable limits of error. Furthermore, the government has not yet publicly recognized the need for contingency plans for responses to nuclear threats. Perhaps government officials will continue to respond on an *ad hoc* basis, as in the past, or perhaps plans have been developed but not disclosed.

While efforts to improve non-destructive assay and other accountancy techniques designed to detect material theft should be continued, there are compelling reasons why major efforts should be devoted to development of the best practical measures to prevent theft. For one, detection will merely be the event which triggers recovery operations, and these operations might well fail. For another, some prevention measures are also effective means for detection *before* the successful completion of a theft. The signaling of an alarm may also automatically close exits from a facility, as well as summon on-site security forces promptly to the scene of an attempted theft. Some preventive measures should be plainly visible, both as a deterrent to the potential thief who is only casually investigating a possibility and as a way of building public confidence. The psychological atmosphere created by the nuclear safeguards system may be as important as the technical capability of the system.

The public must be as fully informed as possible about the prevention and detection functions of the safeguards system in order to build confidence in its effectiveness. However, the extent to which the recovery and response phases should be revealed to the public is a difficult question. Revealing the details of these parts of the system in order to produce public confidence in their effectiveness could in itself substantially reduce their effectiveness. However, the general public and, even more importantly, any potential thieves must believe that the government has planned carefully about what will be done to recover any stolen material and to respond to any nuclear threat.

FRAMEWORK

In developing a nuclear safeguards system, it is useful to think from a conceptual framework provided by three basic questions: What may be controlled? Who may do the controlling? And what are the means of control? We will discuss the first two questions here. Specific measures to prevent nuclear diversion, to detect completed nuclear thefts, to recover stolen nuclear materials, and to respond to nuclear threats will be explored in Chapter 8.

What May Be Controlled?

Nuclear *material* flows through and between a variety of *facilities,* from mines to radioactive waste storage. Special *information* is necessary in order to build and operate the facilities and produce, process, and use the materials flowing through the nuclear fuel cycles. And of course, nuclear industry would not happen without *people.* Thus, material, facilities, information, and people may be the subjects of control under a nuclear safeguards system.

Materials. Nuclear safeguards systems are based primarily on controls over materials which flow through the various nuclear fuel cycles. Therefore, detailed discussion of this aspect of safeguards is necessary at this point.

All nuclear material may be subject to safeguards. Control measures may be initially applied to every shovelful of ore containing uranium or thorium that is removed from the ground, or they may even apply to deposits of uranium and thorium ore in the earth's crust. Safeguards may extend to nuclear material as it flows throughout the fuel cycle and continue to apply to material that is recycled after chemical reprocessing. Measures to ensure against theft may apply to the fissionable material that is produced in a nuclear reactor and to each successive generation of fissionable material as it is produced. Safeguards may even extend to radioactive waste material that is stored permanently. Such a comprehensive control scheme is now unrealistic and unworkable. However, the original proposals for nuclear disarmament proposed by the U.S. government at the end of World War II—the so-called Baruch plan—called for just such a comprehensive scheme. At that time, the government believed such a scheme to be necessary as a precondition for the destruction of its own stockpile of nuclear bombs, which was then very small, and as a worldwide regulatory framework for the development of industrial uses of nuclear energy.

Alternatively, a variety of exemptions from a particular safeguards system are possible. Nuclear material may be exempt when it is present only in small quantities or in certain forms. Thus, if the total quantity of plutonium or high-enriched uranium in a country is less than one kilogram, that quantity is exempt from international safeguards under the NPT. Nuclear material may also be exempt from a certain safeguards system, or those safeguards may be suspended and another system imposed if and when the material is being used for certain purposes. Thus, material may be exempt from the safeguards applicable to civilian industry when it is used under governmental authority in the manufacture of nuclear weapons or in military propulsion reactors.

The establishment of safeguards exemption limits for small quantities of material raises a number of difficult questions. Should the exemption limits be related directly to the minimum amount of a particular fission explosive material that is required to make one nuclear explosive? If so, how should this amount be determined, and by whom? In some of our previous discussions, we have used the well reflected, spherical critical masses of plutonium, high-enriched uranium, and uranium-233 at normal densities as points of reference. As discussed in Chapter 2, however, it has been widely published that an implosion system can be used to significantly compress the core of fission explosive material, and the critical mass decreases as the compression increases. Therefore, it would seem possible that significantly smaller quantities of these materials than their critical masses at normal densities can be used to make fission explosives. But how much smaller, and how dependent is the minimum amount on the knowledge and skills of the weapon designers and fabricators? Are thresholds for exemption related to the types of fission explosives that could reasonably be expected to be designed and built by one individual in a basement type operation? By a highly competent, but small non-governmental organization? By the participants in an intensive, long-term effort sponsored by an industrially advanced nation? Given the fact that answers to these questions require access to classified information, how can the public be assured that the limits established are reasonable?

Perhaps even more difficult questions, which are largely matters of subjective judgment, involve the possible eventual pooling of stolen materials, as in a black market. Even if it were possible to specify the minimum amounts of various materials that it is reasonable to expect could be used in an illegal fission explosive manufacturing effort, what portion of these amounts should be exempt from physical protection? Should the specified portions be time-dependent, allowing for the possible buildup of black market stockpiles and rates of flow?

It may also be argued that the establishment of exemption quantities should take into account the potential hazards represented by different materials if they were used for non-explosive radiological threats. As we have seen, very small quantities (grams) of plutonium could be used in radiological weapons, whereas many kilograms of uranium-233 would be required to produce comparable hazards. However, high-enriched uranium, even in very large quantities, is categorically unsuitable for non-explosive radiological weapons.

If risks of theft of plutonium-bearing fuel materials or concentrated fission products for use in radiological weapons are taken into account in setting exemption limits, how are these limits to be chosen, and by whom? Should the limit on plutonium be set at one gram? Ten grams? One hundred grams? In any event, the present exemption limits of one kilogram (IAEA and AEC limits for materials accountancy) or two kilograms (AEC limits for physical protection) are too high if radiological threats with plutonium dispersal devices are taken seriously.

There are also difficult questions concerning the exemption of certain nuclear materials from safeguards requirements for physical protection, based on the extent of the dilution of fission explosive materials by other materials. Dilution of uranium-235 with uranium-238 is a special case of this. Below what enrichment level, if any, should an exemption for uranium be established? The 20 percent enrichment threshold which is presently used by the AEC for physical protection is rather arbitrary, since fast critical assemblies can be made with uranium enriched somewhat below 20 percent, though not as low as the 3 to 5 percent enrichment level used for LWR fuel. But how about other dilutants? It may be argued that the dilution of high-enriched uranium with graphite and silicon carbide as in HTGR fuel assemblies, where the dilutants are very difficult to extract, should be used as the basis for safeguards exemptions similar to the existing exemption for low-enriched uranium.

Alternatively, it may be argued that the present AEC exemption from physical protection requirements of low-enriched uranium should be narrowed. More than half the separative work required to produce 90 percent enriched uranium has been done in enriching uranium to 3 to 5 percent for LWR fuel. It is true that further enrichment of 3 to 5 percent fuel is required in order to use it in a workable nuclear explosive, and the risk that a criminal or terrorist group might possess its own enrichment capability is now very small. But this possibility may become more likely in the future.

Regardless of their quantity, ores containing nuclear material may be entirely exempt from control or exempt up to a large limit because the difficulty and cost of processing the materials to usable form make the risks arising from theft negligible. For similar reasons, quantities of refined U_3O_8 (yellowcake) prior to enrichment may be exempt, although the concentration of uranium in yellow cake is very much greater than its concentration in ore. Here again the justification for the exemption of even these materials from safeguards may be undercut by future developments in enrichment technology.

On balance, given the projected size of the flows of plutonium and high-enriched uranium through the nuclear power industry in the U.S., it is reasonable to expect that potential thieves would prefer these fission explosive materials to low-enriched uranium. Therefore, less stringent controls on low-enriched uranium, as part of the "graded" safeguards system advocated by many governments and industrial officials, seems reasonable for the present and near future. If a graded safeguards approach is adopted, it is also arguable, as indicated above, that fission explosive materials highly diluted by other materials that are very difficult to extract should be subject to less stringent requirements than undiluted fission explosive materials.

Based on the preceding discussion, Table 7-1 is a tentative listing of nuclear material categories. The table is presented to illustrate the concept of "graded" safeguards and is not a specific proposal for a classification system. The various classes are listed in decreasing order by the degree to which safeguards might be applied to a "strategic" quantity of each material.

Table 7-1. Possible Nuclear Material Categories for a System of "Graded" Safeguards

	Class	*Examples*
I.	Undiluted fission explosive materials.	Metallic plutonium, high-enriched uranium, or uranium-233. Oxides or carbides of above materials.
II.	Materials suitable for radiological devices whether or not diluted with materials.	Plutonium.
III.	Fission explosive materials diluted by other materials that can be separated without isotope separation or "hot-lab" processing facilities.	Plutonium nitrate solution. Mixed plutonium and low-enriched uranium oxides. Mixed thorium and high-enriched uranium oxides. HTGR silicon coated fuel particles.
IV.	Low-enriched uranium, whether diluted or not.	LWR fuel (without plutonium recycle).
V.	Natural uranium	UF$_6$ (enrichment plant feed) · U$_3$O$_8$ (yellowcake) · Uranium ore.
VI.	Thorium	All forms of thorium.

A "strategic" quantity is *related* to the minimum amount required to produce one fission explosive or radiological device that could be used effectively to attack an area of some specified dimensions. The term "strategic quantity" may be very difficult to define for any particular material. We nevertheless see no way to avoid the problem of defining such quantities; otherwise the concept of graded safeguards becomes meaningless and the fact that some nuclear materials are more dangerous than others is ignored.

Therefore, one of the first steps in the detailed design of a safeguards system, must be to establish values for strategic quantities of the various nuclear materials used in all fuel cycles, quantities below which safeguards are not to be applied. For fission explosive materials, values should be established in a classified analysis, although the values determined should be made public. For ratioactive materials that could be used in dangerous radiological devices, this could probably be done without reference to classified information.

Table 7-1 shows some materials, such as plutonium in various forms, as falling into two categories (Class II and Class III). One might argue that Class II should be considered separately from the others, or that such materials should be at a different level from the one we have chosen. We have simply found it difficult to decide whether the overall risk of theft of materials for use in fission explosives is greater or less than the risk of theft of small amounts of plutonium which could cause radiological damage over a large area.

Facilities. Safeguard measures may be applied to all or some of the facilities in the fuel cycles through which nuclear materials flow. Controls applied to nuclear facilities could be intended to prevent or promptly detect an illicit use of the facility itself–for example, if the facility were used for the secret processing of nuclear material which was not subject to safeguards. Such controls are important at the international level, although they are effected indirectly through material accountancy requirements. To the extent there is a danger that nuclear enterprises might engage in material diversion, such accountancy requirements would also be important to national governments.

By far the most important controls applied to facilities, however, are those intended to reduce the vulnerability of material in them to diversion. In this respect, the physical protection measures used at different facilities may also be "graded," as suggested in the following examples: storage facilities for high-enriched uranium or plutonium oxides vs. storage facilities for fuel assemblies containing highly diluted nuclear material; transportation systems for shipment of high-enriched uranium hexafluoride vs. those for shipment of low-enriched uranium LWR fuel assemblies; LMFBR fuel fabrication plants and LWR plants with plutonium recycle vs. LWR fuel fabrication plants without plutonium recycle.

Information. Control measures may also be applied to nuclear information. Governmental classification, industrial secrecy and legal protection of trade secrets and patents are examples of kinds of information controls. The U.S. government has adopted a classification scheme and stringent control measures to restrict the flow of certain nuclear information within the United States and from the United States to other countries.

At present, the only remaining areas of classified information relevant to the nuclear theft problem involve uranium enrichment processes and the design and manufacture of explosives. Other information is widely available, including detailed information concerning reactors, fuel fabrication, and reprocessing.

However, just because information is available does not mean that anyone can use or misuse it. Some nuclear processes are complex and are not understood without considerable scientific or technical education. But, in general, the most that should be expected from controls on access to nuclear information is a delay before the "cat gets out of the bag." It is noteworthy that the IAEA is specifically authorized under its statute to establish and administer safeguards applicable to nuclear information, but this authority has remained unused and is generally considered to be unworkable as a basis for safeguards.

People. Finally, controls may be applied to people. These controls may be applied to all persons, or to all those possessing certain knowledge concerning nuclear science or technology, or may be limited to employees of nuclear enterprises and others with access to nuclear activities. Of course, such controls would be a restriction on human freedom, but they may be justified in view of the risks of theft. For example, as mentioned in Chapter 5, the AEC has requested Congress to enact legislation permitting the government to administer an approval program for persons who have access to significant quantities of nuclear weapon material. The legislation is intended to provide a regulatory basis for improving the assurance of the trustworthiness of such persons.

Who May Control?

One or more of a variety of persons and institutions may act as controllers of material as it flows through the nuclear fuel cycles.

Employees. Individual employees of enterprises that produce, process, use, store, or transport nuclear material may be assigned safeguarding duties. Responsibility for safeguards at the employee level may be fixed on one or a few employees at a nuclear facility or spread among all employees. Control responsibilities may be imposed on individual employees by management as an operational procedure, or by a governmental authority as a legal duty.

Given the amount of ~~the~~ nuclear material flows involved, the incentives for theft, and the uncertainties inherent in any technical measures, it seems clear that no nuclear safeguards system can be effective without the participation of the employees of nuclear operations. Each employee should be fully informed about the risks and consequences of nuclear theft where he is employed. He must clearly understand his duties related to its prevention and detection. And finally, he must comprehend that the penalties for failure to perform his safeguarding duties, or for engaging in any unlawful diversion attempt himself, will be swift and severe.

Enterprises. Nuclear enterprises may have safeguarding duties related to the prevention and detection of theft. The managers of an enterprise will, of course, have a vital financial interest in efficient operations. Up to a point, a manager can be expected to take measures to ensure that nuclear material is not lost or stolen. That point will be reached when the marginal cost of safeguards to the enterprise exceeds the prospective cost of material lost, wasted, or stolen, regardless of the potential cost to society as a result of a successful nuclear theft. It is clear that certain measures will be necessary at the enterprise level which would not be developed or implemented by management on its own initiative. A governmental authority must impose these measures as legal duties on the enterprise. At the enterprise level, responsibility for failure to perform, or negligence in performance of safeguarding duties may be imposed on the enterprise as a whole or on the managers of the enterprise, or both.

Governments. Governmental authorities may not only impose duties and fix responsibilities on others regarding implementation of nuclear safeguards, but may themselves perform control functions and assume safeguarding responsibilities. Moreover, various levels—national, state and local—and kinds—licensing and enforcement—of governmental authority may be brought to bear in different ways. What a government *can* do depends on the jurisdictional and constitutional limits of its authority, and by the technology available. What a government *will* do in regard to safeguards is, of course, a political matter.

International Agencies. International organizations may also have duties and responsibilities regarding nuclear safeguards. It is important to recall that the safeguarding duties and responsibilities of an international organization such as the IAEA have been delegated to it by member states. In general, these functions may be exercised on the territory of a member state only with the consent of its government. The United States government has offered to permit the application of IAEA safeguards to all nuclear activities in the United States, except those of direct national security significance. This offer, which is still outstanding and remains to be implemented, is intended mainly for political effect; namely, to play down the discrimination inherent in the Non-Proliferation Treaty between nuclear-weapon and non-nuclear-weapon countries. Neither the offer nor its implementation bears importantly on the problem of theft of material from the nuclear power industry in the U.S. It is intended to help reduce the risk of governmental diversion in other countries through widespread adherence to the treaty.

Chapter Ten

Conclusions and Recommendations

CONCLUSIONS

Nuclear Weapons Are Relatively Easy To Make, Assuming the Requisite Nuclear Materials Are Available.

Fission explosives can be made with a few kilograms of plutonium, high-enriched uranium, or uranium-233. Assuming sufficient material is available for a fast critical mass, the yield of a fission explosive device will depend on the quality of the fissionable materials used and, most importantly, on the design. The design and fabrication of a simple, transportable, fission explosive is not a technically difficult task.

The most effective type of radiological weapon appears to be a plutonium dispersal device. Such a device requires much less plutonium and is simpler to make than a fission explosive.

The effects of a nuclear weapon depend on the characteristics of the device and the target area. The effects of a crude, low-yield fission explosive can be sufficiently intense and widespread to kill tens of thousands of people and cause hundreds of millions of dollars of property damage. A plutonium dispersal device can cause radioactive contamination and a serious health hazard until costly and difficult clean-up operations are complete.

The Use of Nuclear Energy To Generate Electric Power Will Result in Very Large Flows, in Various Nuclear Fuel Cycles, of Materials that Can Be Used To Make Nuclear Weapons.

By 1980 tens of thousands of kilograms of nuclear weapon materials will be present in the U.S. nuclear power industry (and several thousands of kilograms will be present in civilian fuel cycles in a number of other countries with large nuclear power industries). Thereafter, the total amount of nuclear weapon materials involved in nuclear power industries throughout the world is expected to increase rapidly for many years.

Safeguards aside, possibilities vary significantly for theft of nuclear weapon materials from the fuel cycles related to each of the major types of power reactors in use or under intensive development:

In the light-water reactor (LWR) fuel cycle without plutonium recycle, plutonium which is produced in a power reactor, if reprocessed, might be stolen at the output end of a reprocessing plant, during transit from the reprocessing plant to any separate storage facility used, and from a long-term plutonium storage facility. Until irradiated fuel is reprocessed, the theft possibilities in the LWR fuel cycle are minimal.

In the LWR fuel cycle with plutonium recycle, in addition to possibilities without recycle, plutonium might be stolen during transit from any separate long-term storage facility, and from a fuel fabrication plant. Complete LWR fuel assemblies, each containing a significant quantity of plutonium might also be stolen during transit from a fuel fabrication plant to a power reactor, and at a power plant prior to loading into the reactor, although the weight of each assembly makes this difficult.

In the high-temperature gas-cooled reactor (HTGR) fuel cycle, high-enriched uranium might be stolen from the output end of an enrichment plant, during transit from an enrichment plant to a conversion plant (if at a different location), at a conversion plant, during transit from a conversion plant to a fuel fabrication plant, and during processing at a fuel fabrication plant until the material is diluted with large amounts of carbide. Complete HTGR fuel assemblies, each containing significant quantities of high-enriched uranium might also–like plutonium-bearing LWR fuel assemblies–be stolen during transit from a fuel fabrication plant to a reactor and prior to fuel loading at the reactor. However, the high-enriched uranium contained in HTGR fuel assemblies is considerably less per equivalent weight, and it is more difficult to separate from dilutant materials than plutonium contained in LWR fuel assemblies.

The theft possibilities regarding uranium-233 produced in an HTGR, assuming recycle has not begun, are parallel to the possibilities for plutonium theft from the LWR fuel cycle without recycle. Until irradiated HTGR fuel is reprocessed, the uranium-233 theft possibilities are minimal. When uranium-233 is recycled in HTGR's or some other reactor, the theft possibilities will parallel those in the LWR fuel cycle with plutonium recycle.

In the liquid-metal fast-breeder reactor (LMFBR) fuel cycle, the possibilities for plutonium theft will parallel those in the LWR fuel cycle with plutonium recycle. However, complete LMFBR fuel assemblies contain plutonium in a much higher concentration, and it is much easier to extract than plutonium-bearing LWR fuel assemblies. It is also possible that LMFBR's will initially use some high-enriched uranium fuel, resulting in possibilities for theft parallel to the possibilities for diversion of HTGR fuel.

At present, it is reasonable to exclude low-enriched uranium which is used as LWR fuel, from the category of nuclear weapon materials. The justification for the exclusion is the absence of an isotope enrichment method that is relatively simple or practical to use on a small scale. This rationale should be subject to careful review in light of developments in gas centrifugation and laser techniques.

Without Effective Safeguards To Prevent Nuclear Theft, the Development of Nuclear Power Will Create Substantial Risks to the Security and Safety of the American People and People Generally.

Individuals or groups may attempt to steal nuclear weapon materials for money or to engage in political coercion. It would be relatively easy for a small group possessing nuclear weapon materials to use them in any number of ways to threaten other groups within society, governments, or entire communities. The frequency and character of nuclear theft attempts in the future is likely to be influenced greatly by the general political climate and by prevailing attitudes toward violent behavior within societies where opportunities exist for such theft. Factors over which the nuclear power industry has no control will thus largely determine the range of threats a safeguards system must deal with.

The U.S. System of Safeguards Is Incomplete at This Time. Although Regulatory Actions Have Strengthened Requirements Substantially, Some Basic Issues Pertaining to Physical Protection Measures Have Not Yet Been Resolved.

In some areas, the AEC has taken regulatory actions which, if fully implemented, will constitute important building blocks in an effective U.S. system of safeguards against nuclear theft. Among these are:

1. the regulatory guide, Control of Personnel Access to Protected Areas, Vital Areas, and Material Access Areas issued in June 1973 (see Appendix C); and
2. the new regulations prescribing nuclear material control and accounting procedures, which establish specific limits of error of nuclear material unaccounted for.

In many areas, present U.S. safeguard requirements are vaguely defined. In some of these areas, the AEC is presently developing more detailed regulatory guides concerning, for example:

Safeguards against use of nuclear material for weapons

by B. Sanders and R. Rometsch, *International Atomic Energy Agency*

Almost from the first supply, by one State to another, of nuclear material and equipment, measures have been taken to keep such supplies from furthering military purposes. The word *safeguards* to describe such measures first appears in a declaration of November 1945, by the Governments of Canada, the United Kingdom and the United States, on their joint policy in the area of atomic energy. This gave only the vaguest indication what the term *safeguards* would entail: "... inspection and other means". The concept has been greatly developed since 1945, in thinking and in practice.

In January 1946, during its first session, the United Nations General Assembly set up the United Nations Atomic Energy Commission (U.N.AEC), in which the U.S.A. submitted its so-called "Baruch Plan". This plan foresaw managerial control on ownership of all atomic energy activities by an international body.

It was not realized. In spite of lengthy discussions in the U.N.AEC, the Security Council and the General Assembly military nuclear activities went ahead. Test explosions in the U.S.S.R. in 1949 and by the United Kingdom three years later, the stockpiling by the United States of large amounts of nuclear material for military use and the fact that several other States had obviously already gone in for nuclear activities on a considerable scale had proved that there was no longer time to establish an authority for the world-wide control of all nuclear materials. Thus, the element of international ownership and managerial control disappeared from the concept of safeguards.

The Agency is established

In 1953, the President of the United States submitted his "Atoms for Peace Plan" to the U.N. General Assembly. This proposed the creation of an international atomic energy agency through which all international co-operation in nuclear affairs would be channelled. The agency would have at its disposal a "pool" of nuclear material that was to be used exclusively for peaceful purposes. Already the first sketches of the statute of the international agency foreseen contained the right to apply safeguards and to verify the use of the material allocated by it to any State.

The Statute of the International Atomic Energy Agency was opened for signature in October 1956. It contains safeguards provisions which are described throughout the text. The basic provision in Article II requires the Agency to "ensure, so far as it is able, that the assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose".

The Statute merely provided the basis for the Agency's safeguards and was never meant to be more than the framework of a safeguards system. The substance of such a system would have to be found in the agreements between the States concerned and the Agency. This made it necessary to work out a set of procedures for uniform application in connection with all safeguards agreements.

These procedures would convey the actual substance of the concept of safeguards.

A first safeguards system

On the basis of a set of proposals prepared by a special working group, the Agency's Board of Governors, in 1961, adopted the first safeguards system, which was conceived only for reactors with a thermal output of less than 100 MW. In 1964 the system was extended also to reactors of greater power and at the same time a beginning was made with the review of the system. This resulted in 1965, in the adoption of the system now generally referred to by the number of the document in which it was published: INFCIRC/66. All safeguards agreements concluded from that moment on incorporated the system laid down in this document. In 1966, the system was extended by provisions for reprocessing plants and in 1968 by further provisions for safeguarding nuclear material in conversion and fabrication plants. The complete document, including the two additions, is now referred to as INFCIRC/66/Rev.2.

The provisions of the document become legally binding only to the extent that they are incorporated in a safeguards agrement and the extent to which they are incorporated depends on the specific situation. The document itself is flexible in this respect and leaves room for deviation. It can obviously not be considered in isolation from the various agreements.

There are three categories of such safeguards agreements: (1) those by which parties to a bilateral agreement for co-operation in the nuclear field transfer to the Agency the right and obligation to apply the safeguards foreseen in such agreements—the so-called "safeguards transfer agreements"; (2) those by which States submit all or a defined part of their nuclear activities to Agency safeguards—the so-called "unilateral submission agreements"; and (3) those providing for assistance given by the Agency—"project agreements".

The former two categories of agree ment are particularly relevant to th present situation. The main reason for a State to enter into a safeguard agreement are either because it ha become a party to an international in strument like the Non-proliferatio Treaty or the Treaty of Tlatelolc (the Treaty for the prohibition o nuclear weapons in Latin America or to fulfil obligations it has accepte in order to obtain nuclear materia equipment or technological know-ho from another State.

As the international trade in th nuclear field increases and exportin States wish to make sure that the supplies do not further any militar purpose, the unilateral submissio agreements are becoming more fr quent. A number of exporters a bound by the NPT which, in Artic III·2, requires parties not to provi nuclear material or equipment or ma erial especially designed or prepare for the processing, use or productio of special fissionable material witho safeguards. Other exporters, not pa

B. Sanders and R. Rometsch. Safeguards against use of nuclear material for weapons. Nuclear Engineering International. September, 1975. pp. 682-685. Reprinted with permission, Nuclear Engineering International.

ties to the Treaty, have made it a policy to follow the same approach.

This development has made it necessary to obtain a greater degree of standardization in the agreements concluded pursuant to INFCIRC/66/Rev.2, particularly in respect to the duration and termination of such agreements. Recently the Agency's Board of Governors formally adopted a policy that rights and obligations to apply safeguards should remain in force as long as the supplied items or any special fissionable material produced in or by their use are in actual use in the State. The evolution of the INFCIRC/66/Rev.2 system does not stop here. In the light, particularly, of the tendency to require that the supply of certain important nuclear items should "trigger" safeguards of the same type the supply State has accepted for his own nuclear effort, it may be expected that the document will, in the near future, undergo important changes.

NPT initiated

On 1 July 1968, the Treaty on the Non-proliferation of Nuclear Weapons was opened for signature and immediately afterwards, the Agency started its preparations for the role it would have to play under the Treaty. Consultations were convened to analyse the way in which the Agency should apply safeguards in relation to a country's entire range of peaceful uses of nuclear energy, to ensure that such safeguards would be effective, economic and widely acceptable. Several panels of experts were also called to advise on specific aspects of the Agency's future work, notably on the information requirements for the safeguards system and on systems analysis of nuclear fuel cycles.

The Treaty entered into force on 5 March 1970 and immediately thereafter the Board of Governors of the Agency established a committee to advise it on the content of the agreements which would be required in connection with the NPT. All Member States of the Agency were invited to communicate their views on the implications of the NPT to the Agency's safeguards activities. The committee convened in June 1970 and completed its work in March 1971, after eighty-two meetings. Delegates from forty-eight States participated. The committee's report was couched in the form of recommendations for the contents of safeguards agreements and contained a complete safeguards system designed to enable the Agency to apply safeguards pursuant to the NPT. On 20 April 1971, the Board authorized the Director General to use this material as the basis for negotiating agreements required by Article III of the NPT. It is known by the number of the document as the "INFCIRC/153 system", or, by the colour of its cover, as the "Blue Book".

The INFCIRC/66/Rev. 2 system still forms the basis for the greater portion of the Agency's safeguards activities. At the time the NPT entered into force, the Agency was party to safeguards agreements with thirty-two States and at the time of writing there are still sixty-two agreements of this type in force, although twenty-five of these had been suspended as the State had concluded an agreement in connection with the NPT. The Blue Book has formed the substance of every safeguards agreement so far concluded pursuant to the NPT, but here, too, an important development has since taken place. It is described below in connection with the discussion on the role of the "States' System".

The thirty years history of safeguards is one of continuous development and there is no reason why its techniques and concepts should not undergo many further changes.

Today's rationale

Before their review and adaptation to NPT the documents describing the Agency's safeguards system stated that the Agency's purpose was to comply with the statutory obligation of ensuring that "assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose". None of the documents sets out the technical objectives of safeguards nor do they specify what conclusions are to be drawn from the verification activities.

A major step in that direction was made when the Safeguards Committee (1970) laid down the structure and content of safeguards agreements in connection with NPT. The objective of safeguards was then clearly defined (and is now repeated in each agreement) to be *the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.* The agreements in relation to NPT provide further that the technical conclusion of the Agency's verification activities shall be a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving limits of accuracy of the amounts stated. Thus, NPT safeguards are directed towards obtaining quantitative statements that leave room for reasonable judgement.

The inclusion of the expression "or for purposes unknown" is of great importance for the practical application of safeguards. This expression means that the safeguards inspectorate has not to prove that specific explosive devices have been manufactured, a task almost impossible in practice, but must establish proof for the presence or consumption of the nuclear material in peaceful activities. The disappearance of nuclear material is considered to constitute diversion in itself. Nuclear material accountancy becomes consequently the safeguards measure of fundamental importance. In view of the inherent uncertainties of an accountancy based on measurements and chemical analysis—as opposed to counting of discrete items—it is necessary to lay down quantitatively a number of parameters to determine the desired level of accountancy. The provisions in agreements on the technical conclusions to be drawn from the Agency's verification activities give the guideline for that determination. The rationale to be used must distinguish between the facility operator's accountancy and the accountancy maintained by the Agency on the basis of its verification.

Accountancy and verification

The operator of any nuclear facility is bound to establish nuclear material accountancy for his own purposes. He keeps records and sends reports to the Agency, in accordance with the requirements defined in the safeguards agreements and related subsidiary arrangements. These records and reports cover initial inventories of nuclear material and subsequent inventory changes. Additions to and subtractions from the initial inventory yield the "book inventory" defining the nuclear material which should be in a given material balance area. Periodically, the facility operator takes a "physical inventory" establishing thus what actually is in the material balance area. Because of the inherent measurement uncertainty there is usually some difference between these two inventories which is defined as the "material unaccounted for or MUF. As a variable derived from measurements MUF, like the measurements themselves, is subject to uncertainties.

The system of measurements used for the material balance accountancy is required by the agreement to conform to the latest international standards. Thus, the results provide the operator himself with the best possible knowledge regarding the whereabouts of his nuclear material.

For the verification of the facility operator's material accountancy the Agency's inspectorate must make use of statistical techniques. The numerous components of a material balance—the receipts into the material balance area, the shipments out of it and all the batches making up the beginning and the ending inventory—are crosschecked by independent measurement or chemical analysis, on the basis of a random sampling plan. At the same time the accounts are audited for internal consistency and compared with the reality. During this process diversion based on accountancy falsification would be detected.

Carefully designed random sampling plans for the verification through inspection and a corresponding statistical analysis of the collected data permit the Agency to assess the accuracy of the operator's accounts with a known degree of uncertainty. At this stage probabilities are introduced. The Agency has fixed, on the advice of technical panels, the degree of probability of detecting the above mentioned significant quantity, if missing, at 95%, and the probability that this quantity has been correctly established (confidence level) also at 95%. In this context the term "significant" is used in the sense given to it in statistical analyses. The first, quantitative technical objective of verification is thus to determine with the given probabilities and based on the state of the art in nuclear material measurement that significant quantity which can be detected, if it is missing.

This significant quantity is then continuously compared with the "threshold amounts" of nuclear material needed to manufacture a nuclear explosive device. Upper limits of such threshold amounts have been considered by international experts advising the Agency to be 8 kg of plutonium per year and 25 kg of contained uranium per year.

A comparison with the best available accuracy figures obtained in closing material balances shows the need for additional actions. There are on the one hand facilities in which the significant quantities for a material balance period of one year would be larger than the threshold amount and on the other hand situations where the significant quantity represents only a small fraction of the threshold amount. In the latter case the introduction of "graded safeguards" by classification of nuclear material and the setting of the quantity defined as technical objective higher than the statistically significant quantity provide important possibilities of optimizing cost/effectiveness. Statistically significant quantities greater than the fixed threshold amounts will occur more and more in reprocessing plants and other facilities in which plutonium is handled in bulk form. There it is necessary to increase the frequency of physical inventory taking and hence close the material balance several times per year. In addition, accountancy measures are complemented by using the physical containment inherent in the type of nuclear installation as well as the application of surveillance, preferably by means of automatic instrumentation.

Evaluation of the quantity of "material unaccounted for" and the uncertainty with which this quantity is known, qualified by the applied probability parameters, lead to the final conclusion by the Agency on diversion or non-diversion. When all possibilities of further investigation are exhausted such a conclusion may take the form for an individual material balance area, that "not more than a given quantity of nuclear material, stated with a confidence level of 95% and a detection probability also of 95%, can be missing".

The States' systems

The safeguards agreements in connection with NPT contain the requirement that the State shall establish and maintain "a system of accounting for and control of the nuclear material subject to safeguards". The Agency is required to make full use of this national system, take due account of its technical effectiveness and avoid unnecessary duplication of the State's accounting and control activities. The Agency's verification shall include, however, independent measurements and observations. Actual co-ordination of the States' activities with the safeguards work of the Agency is not foreseen in the "Blue Book". In fact, the State has a wide variety of possibilities in establishing the accountancy and control system. One possibility consists in merely regulating the accountancy procedures of the facility operators and taking over their accounts as those of the State. But a State may also decide to establish its own nuclear material accountancy system, even to verify fully the operators' accountancy by independent measurements with a narrowly set technical objective.

Where the latter is the case, the Agency may be materially assisted in its work and may reduce its own verification activity as it has to take into account the extent to which the operators are functionally independent of the States' accounting system for determining the actual number, intensity, duration, timing and mode of routine inspections. Then it becomes important to work out details of co-ordination between the Agency's and the States' verification. This has been done for the first time in connection with the agreement between the European Atomic Energy Community, its non-nuclear weapon Member States and the Agency, in which case the existing EURATOM safeguards system has taken over the role of accountancy and control system for the entire group of States. The co-ordination arrangement between the two inspectorates has been laid down in an additional protocol to the agreement. Recently a similar co-ordination protocol containing the same technical elements has been negotiated with Japan, where the national system is envisaged to provide also for intensive verification applying continuously a number of strict criteria. The twenty-two other NPT safeguards agreements covering significant nuclear activities are implemented with the help of States' systems of various sophistication, none of which, however, includes independent verification.

In recent years the question of theft of nuclear material or sabotage of installations has attracted more and more attention. The protection of nuclear material and facilities against illegal acts is an essential supplement to any safeguards system based on accountancy. There is a general recognition of the need for a State to have a system for the physical protection of nuclear material but the obligation to establish such a system does not arise from the safeguards agreement; the Agency cannot oblige a State to do so. It is, however, in a unique position to render advice on the subject, serve as a clearing-house for information and co-ordinate the various approaches towards concerted action in this field.

Since 1971 the Agency has been preparing itself to provide, upon request, technical advice to States setting up systems for the physical protection of nuclear material. Several meetings of experts from Member States have been convened which resulted in the publication, in June 1972, of "Recommendations for the Physical Protection of Nuclear Material". In February 1975 the experts made a thorough study of developments over the last two years and prepared an updated and extended version of the recommendations. They provide classification of the nuclear material based on its potential hazard and define requirements for physical protection for material in use, storage or transit.

Scope of safeguards work from 1975 to 1980

The magnitude of the safeguards work would seem to depend primarily on the inventory of nuclear material in the fuel cycle required to produce the nuclear electrical power. The long-term planning of the Agency is therefore based on forecasts of nuclear power production as well as on an evaluation of the future development of the entire fuel cycle, including the flow rate through and the hold-up in the different facilities such as enrichment, fuel fabrication and reprocessing plants. Officially and publicly announced programmes show that there is an anticipated increase of nuclear electricity production capability from just over 90 000 MW(e) installed in 1975 to about 300 000 MW(e) installed in 1980. The number of facilities in question is shown in the following table:

Number of facilities in the nuclear fuel cycle

Type of facility	1975	1977	1980
Power reactors	200	280	420
Uranium fuel fabrication plants	24	28	36
Uranium and plutonium mixed oxide fuel fabrication plants	21	23	26
Irradiated fuel reprocessing plants	6	8	12
Enrichment facilities	8	9	10

The inventory of low enriched uranium in the power reactors above is expected to grow to almost 30 000 tonnes in 1980, whereas the cumulative amount of produced plutonium is expected to reach 200 tonnes by that year. However, probably much less than half of this amount of plutonium will be separated out of the irradiated fuel and re-fabricated into mixed oxide fuel for use in thermal and fast reactors.

Safeguards

The safeguards effort and the corresponding expenditures by the Agency are expected neither to increase proportionally to the nuclear electricity production, nor to the nuclear material inventory. There are several reasons for this prognosis. Most important is the fact that NPT safeguards cover the nuclear fuel cycle as a whole and that the plutonium which requires the highest safeguards attention flows through relatively few large facilities. The prospects of further optimization of the inspection design concept, of increased use of rapid, non-intrusive, non-destructive measurements, of the introduction of a fast service for chemical analysis, of more sophisticated States' systems of accountancy and control, etc. etc. inspire confidence that the safeguards work connected with the impressive growth of nuclear activities can well be mastered if the political will to do so prevails.

THE ADEQUACY OF INTERNATIONAL NUCLEAR SAFEGUARDS

PAUL C. SZASZ*

The thunderclaps of Hiroshima and Nagasaki that rang down the curtain on World War II also signalled the birth of a Janus-like creature—an apparently cheap and potentially almost limitless source of energy, the harnessing of which would, however, inevitably involve great dangers: threats to health, safety and property from radiation or possibly even explosions associated with the peaceful uses of nuclear power, and the massive intensification and transmutation of these threats should this power be intentionally applied to destructive purposes. That these dangers would be inseparable from the promises was consequent on the fact that atomic reactors—the only means of releasing substantial amounts of nuclear energy until a fusion process is eventually developed—both use as their fuel and produce as a by-product radioactive and other fissionable materials that in certain forms and concentrations are the ingredients of nuclear bombs.

The degree of concern that these threats have elicited has varied over the years, as has confidence in the various solutions—national or international—proposed or attempted. Just now, the fears appear to predominate on both counts. While regulations in the interest of safety do not fall within the ambit of this short presentation, a liminal clarification might be useful as to the threat of intentional misuse. For twenty-five years the danger was conceived to be solely from governmental action—that is, it was feared that States would, by way of official if not necessarily publicly announced policy, establish military nuclear programs or divert ostensibly peaceful programs to martial ends; there seemed to be no scope here for private enterprise, because of the massive effort required to establish and operate a nuclear fuel cycle and the conceived complexity of producing any nuclear weapons. However, just in the past few years, it has been recognized that crude atomic bombs are not all that difficult to fabri-

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Szasz, Paul C. The Adequacy of International Nuclear Safeguards. Journal of International Law and Economics, 10 J. Int'l L. & Econ. 423 (1975), pp. 423-436. Copyright by the George Washington University. Reprinted with the permission of the George Washington Journal of International Law and Economics.

cate, and that with the projected world-wide growth of nuclear power there soon would be such a glut of nuclear materials that all of these cannot be effectively guarded against determined men.[1] So, while the concern about the intentional misdirection of the nuclear genie has recently increased and bifurcated, protection against the newly perceived danger is still rudimentary because international safeguards were originally designed primarily to counter governmental transgressions.

Over the years, a succession of control systems has been planned and in part implemented to hinder the proliferation of nuclear weapon programs. First came the grandly though unrealistically conceived Baruch Plan, under which all nuclear activities would have been carried out by a single international authority devoted solely to peaceful pursuits, which through its complete monopoly was to be able to prevent the establishment of any military programs. The rejection of this American plan led to a period of strictly national programs carried out in absolute secrecy. When the bankruptcy of this policy was recognized (as successively the Soviet Union, Britain and France became nuclear powers) and pressures for its abandonment mounted, the nuclear powers established bilateral aid programs subject, particularly in the case of the United States, to strict bilateral safeguards, *i.e.*, to controls carried out by each supplying State in the receiving States. From the beginning most of these bilateral arrangements were meant to be transmuted into multinational ones, to be administered by several international agencies established in the mid-1950s: the International Atomic Energy Agency (IAEA), the European Nuclear Energy Agency (ENEA, now NEA) and the European Atomic Community (Euratom).[2] To a considerable extent this transfer of control functions actually took place, though somewhat more slowly than originally expected.

By the mid-1970s, international nuclear safeguards were almost exclusively carried out by the IAEA—though within the

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[1] This concern was first publicized by Theodore B. Taylor. *See* Taylor, *Diversion by Non-Governmental Organizations*, in INTERNATIONAL SAFEGUARDS AND NUCLEAR INDUSTRY 176 (M. Willrich ed. 1973). He expanded on this theme, with Mason Willrich, in their report to the Energy Policy Project of the Ford Foundation. *See* T. TAYLOR & M. WILLRICH, NUCLEAR THEFT: RISK AND SAFEGUARDS (report to the Energy Policy Project of the Ford Foundation, 1974).

[2] The basic instruments establishing each of these organizations are reproduced in IAEA LEGAL SERIES NO. 1, MULTILATERAL AGREEMENTS (1959).

Common Market, Euratom is to retain a residual but subordinate control function. However, the safeguards role of the IAEA—it also has other functions, relating to the promotion of nuclear energy and to safety regulations—is one by no means easy to describe, as it does not derive from nor is it set out in a single instrument, but rather is a complex construct of various international undertakings and instruments that include: its own Statute,[3] pararegulatory Safeguards Documents or Guidelines it has established,[4] the world-wide Non-Proliferation Treaty (NPT)[5] and a regional counterpart, the Tlatelolco Treaty for the Latin Americas,[6] some incipient cartel-like arrangements among suppliers,[7] and bilateral agreements between the Agency and each State in which it is to carry out controls. This study considers neither the involute legal ramifications of these relationships nor their historical development,[8] but only evaluates those factors that bear directly on the effectiveness of controls.

When and What can the IAEA Safeguard?

In a world of sovereign nation States which cooperate through but only rarely subject themselves to international organizations, there is no automatic obligation for any State to submit itself or any of its activities to international nuclear safeguards. Both the UN Charter and the IAEA Statute are treaties by which the members of the respective organizations have undertaken certain duties, but neither contains any obligation to submit to safeguards—or even to refrain from producing nuclear weapons or to assist others in doing so. The IAEA Statute does provide that when the Agency assists a member State in some peaceful nuclear activity, that project must be controlled to prevent any diversion of the Agency's assistance to military purposes.[9] For the rest, the Statute also allows the submission of international arrangements to safeguards and even for unilateral submissions—but both of these would occur on an entirely voluntary basis, at least as far as the Agency is concerned. Naturally, from the point of view of the States concerned, such submissions would be consequent on some other obligations or pressures, whether resulting from domestic, regional or world-wide factors, reflecting political, trade, military or diplomatic forces and calculations.

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[3] Statute of the International Atomic Energy Agency, July 29, 1957, [1957] 8 U.S.T. 1093, T.I.A.S. No. 3873, 276 U.N.T.S. 4.

[4] *See* in particular IAEA Doc. INFCIRC/66/Rev. 2, The Agency's Safeguards System (1965, as provisionally extended in 1966 and 1968); IAEA Doc. INFCIRC/153, The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons: Guidelines for the Negotiation of Safeguards Agreements in IAEA Legal Series No. 9, International Treaties Relating to Nuclear Control and Disarmament (1975).

[5] Treaty on the Non-Proliferation of Nuclear Weapons, March 5, 1970, [1970] 21 U.S.T. 483, T.I.A.S. No. 6839, 729 U.N.T.S. 161 [hereinafter cited as NPT]. Also reproduced in IAEA Legal Series No. 9, *supra* note 4.

[6] Treaty for the Prohibition of Nuclear Weapons in Latin America, May 12, 1971, [1971] 22 U.S.T. 754, T.I.A.S. No. 7137, 634 U.N.T.S. 281 [hereinafter cited as Tlatelolco Treaty]. Also reproduced in IAEA Legal Series No. 9, *supra* note 4.

[7] As particularly urged by the 1975 NPT Review Conference, Review of Article III, para. 7, Final Declaration, NPT/CONF/35/I, Annex I. A number of supplying States have, in effect, already coordinated their export policies to a limited extent, as indicated in the substantially identical communications they have addressed to the IAEA in the course of the past year. *See* IAEA Docs. INFCIRC/209 and /Add.1-6.

[8] The literature on nuclear safeguards is already enormous. *See* Comm. on Government Operations of the U. S. Senate, 94th Cong., 1st Sess., Peaceful Nuclear Exports and Weapons Proliferation: A Compendium (Comm. Print 1975) for a collection and bibliography of some of this material. For a discussion of the IAEA's pre-NPT safeguards *see* P. Szasz, The Law and Practices of the International Atomic Energy Agency ch. 21 IAEA Legal Series No. 7 (1970). For a discussion of the IAEA's safeguards to implement NPT *see* Szasz, *International Atomic Energy Safeguards*, in International Safeguards and Nuclear Industry 73 (M. Willrich ed. 1973).

As the IAEA itself has only given or arranged for assistance to a small fraction of the peaceful nuclear projects undertaken throughout the world, safeguards exercised on that statutory basis cannot constitute a significant bar against proliferation. However, in 1967 the Latin American States formulated the Tlatelolco Treaty banning nuclear weapons from their continent, and in 1968 the UN General Assembly promulgated the similar world-wide Non-Proliferation Treaty, designed to freeze all but the then qualified five nuclear powers into a perpetual non-nuclear posture. Neither Treaty established its own control system, but both in rather similar terms rely on the IAEA to carry out the necessary safeguards, by requiring all non-nuclear-weapon parties to conclude agreements with the Agency providing for safeguards on all their peaceful nuclear activities. These two Treaties thus provide the external obligation requiring States to submit "voluntarily" to IAEA safeguards.

If, therefore, all non-nuclear-weapon States had become parties to one or both of these Treaties, this part of the study could be concluded here, to shift directly to a contemplation of the methods and effectiveness of IAEA controls. Unfortunately, however, many States are not yet parties to either Treaty, including many of the significant threshold States, *i.e.*, those whose technology is sufficiently advanced that they are likely candidates for early membership in the nuclear club. It is true that the NPT contains a provision relating to such non-parties: Article III.2 enjoins parties to the Treaty to give nuclear assistance to non-parties only subject to the same safeguards as are imposed on parties. But this provision, while superficially clear enough, does contain an ambiguity: are the safeguards that are to be required on the basis of external assistance to apply only to such assistance—as is true when it is provided by the Agency itself—or must controls be applied to all peaceful nuclear activities of a recipient State, as would be true in any non-nuclear-weapon State party to the Treaty? With the latter interpretation, Article III.2 would of course constitute a powerful incentive to join, since the receipt of any assistance from a party would bring down the full panoply of IAEA controls. As there is no mechanism in the Treaty for construing its provisions authoritatively and with binding force, the resolution of this ambiguity has depended on the conscience of each supplying State: each is free to adopt a strict interpretation, but may thereby lose lucrative sales to States with a less stern attitude. Here, as everywhere Gresham's law applies, and the "bad" interpretation drives out the "good"; as the nuclear market has become more competitive and the threshold States became the best potential customers, few suppliers have had the fortitude to insist that they would only deal with States that subject themselves to comprehensive IAEA controls. In this respect, however, there is a glimmer of hope on the horizon: yielding to various pressures, and in particular due to a sounder understanding of their own long-range interests, the principal suppliers are finally showing signs of negotiating a limited cartel agreement, whereby none would seek to promote business by offering assistance on more liberal safeguards terms.[10]

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[9] IAEA Statute arts. III.A.5, XI.F.4, XII *supra* note 3.

To recapitulate, non-nuclear-weapon States may at present be obliged to submit to IAEA safeguards on various bases:

> (a) Parties to the Non-Proliferation or Tlatelolco Treaty must submit to comprehensive Agency safeguards on all their peaceful activities.

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[10] *See* note 7 *supra*.

(b) States not parties to either Treaty but dependent on nuclear supplies from countries (whether parties to NPT or voluntarily accepting certain of its obligations) that take a strict view of Article III.2, must submit to similar safeguards.

(c) Non-parties that can content themselves with supplies from the Agency itself or from States that take a permissive view of Article III.2 must merely submit to controls on any assistance received.

(d) Non-parties that need no outside assistance, or that can receive all assistance from other non-parties to NPT that have not voluntarily agreed to apply NPT Article III.2, need subject themselves to no controls at all—and are thus in the same situation as nuclear-weapon States, which may but need not accept IAEA safeguards, whether comprehensively or selectively.

How are IAEA Safeguards Exercised?

It is basic to designing any system of nuclear safeguards to understand that, while in general all fissionable materials are capable of direct use in nuclear weapons or are convertible into materials so usable—and thus some controls should be maintained on all such materials—it is necessary to distinguish clearly between material that constitutes an immediate danger and material that does not. Thus weapon-grade plutonium or highly enriched uranium can be fabricated into a bomb charge in a matter of days; natural uranium, on the other hand, must either be "enriched" in a massive facility or converted into plutonium through a long process of fabrication into fuel elements, irradiation in a reactor and separation in a chemical processing plant; even plutonium already created in a hot fuel element recently extracted from a reactor is at best only mediately available, for the element must first be cooled for some time and then chemically processed.

The previous section indicated that IAEA safeguards are either comprehensive or selective. While the general methodology of applying controls on either basis is the same, there are some important differences. Comprehensive safeguards permit the Agency to control all peaceful nuclear materials and facilities in a State—thus the illicit manufacture of any nuclear weapon or explosive device would require either the diversion of nuclear materials that are under controls or the maintenance of an entire unreported, clandestine nuclear fuel cycle: a source of uranium (a mine or uncontrolled imports), perhaps an enrichment plant, fuel fabrication, reactors and chemical separators—a truly formidable enterprise, whose concealment is feasible only in a vast and rigidly disciplined country. On the other hand, when the Agency controls only certain materials or facilities in some way touched by international assistance, the State may obtain the nuclear materials for weapons either by illegal diversion from controlled activities or by utilizing facilities and materials not under control, which may but need not be clandestinely maintained. Such availability of unsafeguarded facilities makes the exercise of controls more difficult, for it requires that safeguarded material be watched and measured at practically all stages lest some of it be processed secretly; if there are no uncontrolled facilities, nuclear materials need to be thoroughly checked only when they are relatively pure and vulnerable, while most of the time they are practically unusable and inaccessible. Consequently, selective safeguards must be tougher and more intrusive than the comprehensive ones required within NPT parties, and even then they may still be less reliable.

There are four basic, interrelated control measures, all of which are mentioned in the IAEA Statute,[11] elaborated in its several Safeguards Documents and defined in agreements relating to each facility to be controlled.

The first is *design review*, which enables the Agency to familiarize itself with the facility, both to evaluate its capacity for using, processing or producing nuclear materials and to determine how controls can best be exercised. Though this somewhat passive right is only a residue of a more formidable power to approve or disapprove designs foreseen in the IAEA Statute, it is still an important tool to enable the Agency to define and maintain appropriate controls.

Secondly, the Agency requires that operating and inventory *records* be kept on all facilities and materials under control.

Thirdly, on the basis of these records, the State must submit *reports*, both routinely on a periodic basis (with a frequency depending on the quantity and nature of the materials involved) and specially as soon as possible in relation to unusual events, whether deliberate (*e.g.*, an unscheduled reactor shutdown) or accidental.

Finally, and most importantly, the Agency may check all such information, whether relating to facility designs, the accuracy of the records or the truthfulness of the reports, by carrying out *inspections* using its own international staff. Their visits may be either routine or special; while usually announced, some inspections may be carried out on a surprise basis, without any notice; although episodic for smaller facilities, it is foreseen that certain larger ones may require continuous inspection by resident inspectors. It is this right to carry out inspections, at its own initiative, that gives credibility to the IAEA's controls and distinguishes these from supervision exercised in other fields by international organizations that must rely solely on self-policing reports submitted by States, which are only infrequently supplemented by specially negotiated *ad hoc* inspections.

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[11] IAEA Statute arts. XII.A.1, 3, 4, 6, *supra* note 3.

These then are the basic control measures that are included in every safeguards agreement and routinely used by the Agency. They should generally suffice to make it likely that any diversion of controlled items is reasonably quickly detected. Nevertheless, these measures are limited in effectiveness, and are perhaps insufficient to cope adequately with the large nuclear complexes already being planned. Therefore an array of other measures should also be considered, which the Agency might and in some instances already does take—though for the most part it can only do so with the special consent of the State concerned.

One means of increasing the reach of inspectors without adding to their numbers or to the instrusiveness of their visits, is the use of various devices and instruments. For instance, a seal placed across the means of access to nuclear material can assure the Agency by mere periodic inspection for integrity that the secured items have not been tampered with; without such a device either continuous observation of the area, or periodic detailed counting and measuring of the stored material would be necessary. Obviously more sophisticated instruments can also be installed to inform inspectors either during periodic visits or perhaps immediately by remote communication, of what is occurring in their absence. The development of such instruments is specifically encouraged by the NPT,[12] and some of these devices are already being used. While the consent of the State concerned must obviously be obtained for the addition of any such recording or reporting devices to their facilities, and its cooperation must be assured in their maintenance, most facility operators prefer to substitute non-intrusive, though effective, robots for frequent visits by more troublesome humans.

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[12] NPT, Preamble, para. 6, *supra* note 5.

Can the IAEA do anything to assure the physical security of nuclear materials, particularly those in forms readily usable for nuclear weapons? This is a multifaceted problem. First of all, may the Agency insist that a controlled State take measures to assure such security against assaults by private persons? Until recently this was not recognized as a serious problem and thus the existing Safeguards Documents and agreements give no definite relevant authority to the Agency, except for the general principle that the latter may hold a State responsible for all safeguarded materials within its jurisdiction, and may consider as intentionally and by official direction diverted any that is missing without adequate explanation. For this reason, and as consciousness of the danger of private diversion becomes more general, it is likely that States will be pleased to receive, and it is hoped will carry out, practical suggestions made by the Agency in this regard. The Agency has consequently initiated studies of these dangers and of possible countermeasures.[12.1] However, at least for the present and under current agreements, the Agency has no standing to insist on particular measures.

Can the IAEA itself assume responsibility for the physical security of nuclear materials? Actually, its Statute does make this possible, by providing for the deposit with the Agency of safeguarded materials in excess of a State's immediate requirements for peaceful uses; requiring the Agency to establish storage facilities; and foreseeing that the Agency will employ guards.[13] This can of course only be done if the State concerned agrees; however, for the present none has done so in any safeguards agreement, nor is this possibility foreseen in any current Safeguards Document. Of course this does not mean that the Agency might not in the future prepare itself to perform such a function and receive the agreement of some or all States for it to do so. But even if it does, it seems clear that the Agency may at best be able to provide protection only against private depredations, and will never be able to maintain a force of guards sufficient to withstand an attack from governmental forces. The only way the Agency could protect nuclear materials in its charge from such attack is to store them outside of countries where they might be seized (for which again there is some sanction in the Statute[14]), but the

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[12.1] The first such recommendations were issued by the IAEA in September 1975: *The Physical Protection of Nuclear Material* (IAEA document INFCIRC /225, endorsed by IAEA General Conference Resolution GC (XIX) /RES/328).

[13] IAEA Statute, arts. XII.A.5, IX.I.1, VII.G, *supra* note 3.

[14] *Id.* art. IX.H.

removal of materials from the territory of a State that owns them does require its prior consent.

Evidently the most effective way of safeguarding a facility and the material in it is to operate the facility directly—a sound principle initially recognized by the Baruch Plan, which held this to be the only control method adequate to the nuclear danger. Again this possibility is foreseen in the Agency's Statute,[15] and again the principal element lacking at this time is governmental agreement. Fortunately there are also other cogent reasons for having the Agency operate certain facilities, for aside from ease of control there are economic considerations that make it desirable to operate large facilities (*e.g.*, gaseous enrichment plants, chemical separation plants, fuel fabrication facilities and perhaps powerful reactors) on an international rather than on a national basis, since economies of scale might reduce costs for all participants. Tentative suggestions in this sense are being made from time to time[15.1] and should be encouraged.

Finally, account should also be taken of safeguards-related information that the IAEA, which is the central coordinator for nuclear activities throughout the world and is in more or less intimate touch with most persons active in this field, might receive outside of the usual channels for gathering control data. These might include:

(a) Information obtained by the Agency through other activities, such as the promotion of various nuclear projects.

(b) Accusations of a controlled State, based on data that another State obtains from its clandestine sources and openly communicates to the Agency.

(c) Information concerning improper activities in a controlled State that another State may secretly communicate to the Agency.

(d) Information that nationals of a controlled State might communicate to inspectors concerning improper activities.

Although the Agency's safeguards procedures do not provide for account to be taken of information obtained by means such as those described above, neither do they contain any clear prohibition. If received and used at all, it is clear that such data will facilitate the task of carrying out controls and will enhance their effectiveness and credibility, for knowing precisely where to look makes it easier to find misuse. It might even be considered a proper, though rarely mentioned, function of any control system, to convert informally obtained and therefore officially unusable intelligence into a form on which official action might be based.

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[15] *Id.* arts. XI, XIV.B.2.

[15.1] In particular as proposed by Secretary Kissinger in his 22 September 1975 statement in the General Debate at the 30th session of the UN General Assembly (UN document A/PV.2355, p. 48 (prov.)).

To what extent the Agency can actually utilize such types of intelligence depends in part on its Safeguards Documents and agreements. For example, the Tlatelolco Treaty specifically provides for official accusations and consequent special inspections,[16] though these would involve primarily the organs of that Treaty and not necessarily the IAEA. NPT contains no equivalent provision, but the safeguards agreements concluded pursuant to it do permit the Agency to carry out special inspections if it considers that it cannot otherwise fulfill its responsibilities, provide that such inspection may extend to areas not normally subject to controls, and assure that in case of disagreement it is the Agency's Board of Governors that decides definitively on what immediate measures are to be taken.[17]

How Effective are IAEA Safeguards?

Now comes the bottom-line question: How effective are IAEA safeguards? This can of course only be answered by examining the explicit and implicit objectives of the system.

First of all, can Agency safeguards actually prevent a non-nuclear-weapon State from embarking on a military program? Clearly the answer is no! The Agency cannot deploy any force to prevent a State from doing anything. The maximum sanction that it can impose, if its members cooperate, is to withhold further nuclear assistance from an offending State. Of course serious violations must also be reported to the Security Council,[18] which in principle has the power to invoke forceful measures under Chapter VII of the UN Charter.

An additional reason militates against the ability of the Agency actually to prevent abuse. That is the right reserved by all NPT parties to withdraw from the Treaty on three months notice to the other parties and to the Security Council, whenever the State subjectively "decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the state's supreme interests."[19] In other words, if pressed too far, a safeguarded State would undoubtedly withdraw from NPT and denounce further controls.

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[16] Tlatelolco Treaty art. 16, *supra* note 6.

[17] INFCIRC/153, paras. 18,73(b), 77, *supra* note 4.

[18] *Id.* para. 19, and IAEA Statute, art. XII.C, *supra* note 3.

Is it then the objective of the system merely to detect misuse, and to give warning to the world community? While this objective seems more realistic, in practice it faces almost the same difficulty as outright prevention: a State that is knowingly violating the restrictions it has accepted is not likely to cooperate in control measures to an extent that will permit detection. At some stage before such an embarrassment is seriously threatened, it will no doubt denounce controls on some pretext, possibly by withdrawing from NPT.

This second negative conclusion, however, brings us still closer to a realistic statement of the objectives of safeguards. Though the Agency cannot prevent, and may not be permitted to detect misuse, it may, through the threat of detection, either keep controlled States honest, or force them to give sufficient public notice of their intention to adopt a military program to permit the world community, in particular those States especially threatened, to take some countermeasures before actual nuclear potency is attained. Moreover, the information gathered while controls were still being exercised should make it possible to give an estimate of the dimensions of the threat, based on the quantity of nuclear materials readily available for conversion into weapons.

Having thus finally identified a realistic objective, are Agency controls sufficient to attain it? That is, are they sound enough to constitute an effective threat of detection should the officials of a controlled State consider whether or not to choose the nuclear option and whether to do so openly or to try to do so secretly?

First of all, can Agency safeguards detect the diversion of controlled materials? Technically the controls are designed to determine, reasonably rapidly, the disappearance of any militarily significant amount of materials from facilities of the types and capacities now under control. However, as the quantities of such materials increase, the maintenance of any particular level of certainty of such detection requires not only a proportional increase in control efforts, but an actual intensification to an ultimately impractical level—unless some breakthrough should occur, either of a technological or political nature, such as the transfer to the Agency of responsibility for the direct operation of sensitive facilities. Politically, too, there are constraints against overly intensive controls, which may reflect pressures on the Agency itself, on its Board of Governors, on its principal officers and on the inspectors personally; nevertheless, the thoroughly international nature of the entire operation vouchsafes that any serious abuse is unlikely to remain hidden very long, no matter what pressures or promises a potential violator might try to bring to bear. Naturally, in respect of a State subject to only selective controls, such assurance can only extend to the controlled facilities; but if dependence on external supplies is extensive, so that the uncontrolled activities are at most token, the guarantee, while less complete, might be sufficient.

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[19] NPT art. X.1. Such withdrawal also terminates the safeguards agreements concluded pursuant to NPT. *See* INFCIRC/153, para. 26, *supra* note 4.

It is probably hardly necessary to give extensive consideration to the second facet, whether the Agency could effectively detect, in a State subject to comprehensive safeguards, a clandestine nuclear cycle. Although the Agency does not have the right to conduct random fishing expeditions outside of the officially notified facilities, it might, as indicated above, use externally obtained intelligence to demand the right to inspect other specified locations. Furthermore, it seems hardly conceivable that even a large State could maintain entirely separate two massive nuclear cycles, one open and controlled and the other secret—keeping in mind that the frequent presence of inspectors in the country and their contacts with many persons dealing with nuclear matters would mean that even in the most repressed society rumors and news of the construction of large "secret" facilities would reach the Agency long before these became operational.

It can thus be concluded that the IAEA's safeguard system can be, in the States in which it is applied, an effective means to hold governments to the peaceful commitments they have undertaken. Even at the minimum, safeguards constitute an early warning system of prospective misuse, the ultimate value of which depends on the readiness of the world community to deal with undesired candidates for the nuclear club.

Beyond its immediate sphere, IAEA safeguards are today the technically, politically and legally most advanced international control system, which might serve as a model for further arms control measures, as well as for monitoring systems in fields as diverse as drug control, environmental protection and perhaps even human rights.

STATEMENT BY
SENATOR STUART SYMINGTON (D-MO.)
SENATE FLOOR

FOR RELEASE:
TUESDAY, JULY 15, 1975 - P.M.

THE NUCLEAR SAFEGUARDS DELUSION

MR. PRESIDENT:

Accompanied by staff members George W. Ashworth of the Senate Foreign Relations Committee, David A. Raymond of the Senate Armed Services Committee, and General Albion W. Knight, Jr. of the Joint Committee on Atomic Energy, I visited Vienna and Geneva June 29 through July 3 during the Senate recess.

On this trip we explored a number of questions concerning recent developments in the strategic arms race, including the spread of capability to make nuclear weapons in presently non-nuclear states. Those related areas can only become increasingly important to our own security as well as the rest of the world.

In Vienna we held extended talks with officials of the International Atomic Energy Agency (IAEA). This Agency is considered the principal "safeguards" instrument of the Non-Proliferation Treaty to ensure that nuclear technology is not diverted to weapons development.

Unfortunately the position of U.S. Permanent Representative to the IAEA has been vacant for some months; and in light of recent developments, let us hope this does not reflect any loss of interest in the vital work this Agency was set up to perform.

In Vienna we also met with United States and foreign delegates to the talks on Mutual Balanced Force Reductions (MBFR). The United States delegation is ably led by the Honorable Stanley Resor.

When we arrived in Geneva a new round of the Strategic Arms Limitation Talks (SALT) was just getting under way, this after many postponements; and we held discussions with members of the United States negotiating team headed by the Honorable U. Alexis Johnson.

Based upon our deliberations at IAEA, MBFR and SALT, it is apparent that the control of nuclear proliferation and related aspects of arms limitation not only is loose, but is slipping; it appears that the prospects for meaningful arms control have become increasingly doubtful.

The discussions held in Vienna with officials of the IAEA were of special interest in light of the multi-billion dollar nuclear "deal" which had just been concluded between the governments of West Germany and Brazil. Earlier we were informed that this arrangement was first offered to the United States but rejected by this government because we would not allow the export of a complete fuel cycle (including enrichment and reprocessing facilities) which could be used to make nuclear weapons.

Now West Germany, however, a country which has both signed and ratified the Non-Proliferation Treaty (and thereby committed itself "not in any way to assist" another state to manufacture nuclear weapons), has agreed to transfer to Brazil -- a country which has not even signed, let alone ratified, this Treaty -- all the material, equipment and technology needed to establish and operate a full nuclear weapons fuel cycle.

This agreement marks the first sale of a complete fuel cycle to any nation. Note that in this case, the recipient nation is in the Western Hemisphere and possesses extensive uranium deposits.

The German-Brazil "deal" will enable Brazil to produce nuclear weapons for its own possible use as well as for sale to other countries, including Germany.

Questioning of this dangerous arrangement is reinforced by divergent testimony presented to the Senate Foreign Relations Committee by the State Department as against statements released by the West German Government. Last month State testified that the United States protested the deal, tried to stop it, but could not succeed. Later during that same month, however, the Chancellor of West Germany, Helmut Schmidt, stated at a news conference in Bonn that the American Government "has not expressed a word of criticism to us."

In any case, and regardless of who is responsible, for the first time a country which has refused to either sign or ratify the Non-Proliferation Treaty now has been able to purchase a complete nuclear fuel cycle which can be used for a weapons development program.

This demonstrates that the countries which are capable of supplying nuclear technology have been either unable or unwilling to reach a significant agreement among themselves with respect to the transfer of this technology to non-nuclear states. More than that, it is becoming increasingly clear that commercial interests now prevail over consideration of nuclear weapons control. This sale by West Germany to Brazil confirms that fact.

Despite the IAEA inspection system, which over recent years people had been led to believe would check the spread of nuclear weapons, today that Agency actually furnishes no safeguards to check such a spread. During our visit to the IAEA, we found that this Agency does little more than monitor roughly the flow of nuclear materials. It has no power of either prevention or enforcement.

In this regard, the following conclusion of the Acheson-Lilienthal Report of 1946 would appear to still hold true today: "A system of inspection superimposed on an otherwise uncontrolled exploitation of atomic energy by national governments will not be an adequate safeguard."

Any enforcement of sanctions in the case of safeguard violations detected by the IAEA (i.e., diversion of nuclear fuel from peaceful to weapons-development purposes) would appear to be the responsibility of the United Nations. As a Congressional representative on the United States Delegation to the last U.N. session, however, I found the possibility would be remote indeed that the U.N. would enforce sanctions against a country which obtained nuclear weapons.

Turning to the subject of the present SALT negotiations, our visit to Geneva confirmed that progress in SALT has been both slow and tortuous. Summed up, the two parties have not yet achieved any meaningful control over the nuclear arms race; and the pace of new weapons technology, as illustrated by the so-called "cruise-missile", along with additional precision-guided vehicles, seems to be outstripping efforts to curb the arms race.

A great scientist once characterized the nuclear picture of the 1950's as "two scorpions in a bottle."

Today there are six scorpions in that bottle, and we now know that soon there will be many more; so it is becoming increasingly apparent that what any two countries may decide will not necessarily be decisive, no matter how many nuclear weapons they may possess.

Any country which possess nuclear weapons could provide a grave threat to virtually any other country, a condition which implies future danger to all nations.

In this nuclear age, while the spread of atomic weapons continues unchecked, the assurance of any nation that it would not seek nuclear weapons -- or would only seek nuclear explosive devices for "peaceful purposes" -- may only reflect its current public attitude. But, as Lord Palmerston once observed regarding the behavior of nations, "We have no eternal allies, we have no perpetual enemies. Our interests are eternal and perpetual and those interests it is our duty to follow."

In this connection, consider that thirty years ago our two chief enemies in war were Germany and Japan, and two of our strongest allies were the Soviet Union and China; therefore any nation would be foolish to consider present alignments and present appearances of mutual goals to be a permanent state.

In any case, the nuclear genie is now out of control, and the number of scorpions continues to grow.

The Subcommittee on Arms Control, International Organizations and Security Agreements of the Senate Foreign Relations Committee, which I chair, will shortly resume hearings on these non-proliferation issues. These hearings will attempt to find out whether, in the interest of future world peace, we and other countries can avoid the obviously growing danger of a world holocaust by bringing nuclear weapons under meaningful international controls.

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REPORT TO THE COMMITTEE
ON INTERNATIONAL RELATIONS
HOUSE OF REPRESENTATIVES

Role Of The International Atomic Energy Agency In Safeguarding Nuclear Material

Department of State
Energy Research and Development Administration

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

ID-75-65

JULY 3,1975

COMPTROLLER GENERAL'S
REPORT TO THE COMMITTEE
ON INTERNATIONAL RELATIONS
HOUSE OF REPRESENTATIVES

ROLE OF THE INTERNATIONAL
ATOMIC ENERGY AGENCY IN SAFEGUARDING NUCLEAR MATERIAL
Department of State
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DIGEST

WHY THE REVIEW WAS MADE

GAO was asked to provide reports on a broad range of subjects concerning international agreements for peaceful cooperation in the field of nuclear energy. This is GAO's third such report and deals with the role of the International Atomic Energy Agency in safeguarding nuclear material.

FINDINGS AND CONCLUSIONS

The Agency, an autonomous organization under the aegis of the United Nations, administers an international nuclear safeguards program designed to detect diversion of nuclear materials for nonpeaceful purposes.

Its 106 member countries include all nations with significant amounts of nuclear activity, except the Peoples Republic of China and the Republic of China (Taiwan). The latter's nuclear facilities, however, are subject to Agency safeguards. (See pp. 1 and 11.)

Membership in the Agency does not obligate a country to accept safeguards on its facilities. For example, nuclear facilities of major nuclear weapons countries, such as the United States and the Soviet Union, are not subject to Agency safeguards except on a voluntary basis. In addition, India, which exploded a nuclear device in 1974, along with Argentina, Egypt, Israel, Spain, Japan, Pakistan, and South Africa are members with nuclear facilities not subject to Agency safeguards. (See pp. 8, 11, and 13.)

The Agency's safeguards system consists of material accountability, onsite inspections, and surveillance and containment devices such as cameras and seals. The principle is that the detection capability of the system will deter a would-be diverter. However, limitations in the scope and applicability of inspections must be recognized.

--Agency safeguards are designed only to detect diversions on the national level, and it is assumed that member nations will protect nuclear material from terrorist or subnational groups. (See p. 14.)

--Agency safeguards do not include physical protection, the safe international transport of nuclear material, or the safeguarding of nuclear waste. (See p. 28.)

--The Agency does not have the authority to seek out undeclared or clandestine nuclear facilities and cannot pursue or retrieve diverted nuclear material. (See p. 15.)

With the expected spread in peaceful uses of nuclear energy throughout the world, problems encountered in the administration and implementation of the Agency's safeguards system can be expected to increase. They relate to such matters as:

--Adequacy of material accountability records within the member countries and their compatibility with the Agency's system. (See p. 20.)

--Continuing need for more advanced measuring instrumentation. (See p. 21.)

--Equitable apportionment of costs of the safeguards system among member nations. (See p. 22.)

--Differences in safeguards agreements with member countries and their interpretation. (See p. 23.)

Actions the Agency can currently take in the case of nuclear diversion are

--notification to member countries and the United Nations,

- suspension of Agency membership rights and privileges, and
- the recall of Agency-sponsored material and technical assistance.

It is not clear, however, how Agency-sponsored material would be retrieved. (See p. 16.)

In view of dangers involved in the spread of nuclear weapons capability, stronger penalties may be needed for those who might violate their pledge to use nuclear material only for peaceful purposes. (See p. 33.)

Real effectiveness of Agency safeguards is not known. There is no public evidence to show whether Agency safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes. (See p. 16.)

The mere fact that the Agency has never disclosed a diversion is not sufficient assurance for many countries that the safeguards are effective. (See p. 27.)

- Effective international safeguards depend in large measure on the intent and cooperation of the country to which they are applied and the adequacy of technological control and implementation. (See p. 14.)
- U.S. and Agency officials generally conceded that a country could circumvent safeguards if it was willing to assume the risk of detection, incur the expense, and take the trouble to do so. (See p. 20.)
- Since the Agency does not disclose to member nations results of its inspections, on the grounds that proprietary information might be disclosed, the Agency faces the difficult problem of how to assure member nations that safeguards are being applied effectively, fairly, and consistently in all countries. (See p. 27.)

The question of whether U.S. interests are best served through bilateral or Agency safeguards is difficult to answer. Agency safeguards tend to be more uniform and less costly than numerous bilateral safeguards would be. Bilateral safeguards provide the supplier with greater confidence that material it supplied is not diverted but provide no assurances on material supplied by others. (See p. 7.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

As requested by the Committee, GAO did not obtain formal agency comments on this report. However, the report was discussed with officials of the agencies involved, and they generally agreed with the information.

MATTERS FOR CONSIDERATION BY THE COMMITTEE

The Committee, together with the Joint Committee on Atomic Energy, may wish to pursue with executive branch officials major policy matters related to the role of the Agency, including:

--The need for expanding Agency responsibilities in the physicial protection of nuclear material, control of nuclear waste, and safe transport of nuclear materials internationally.

--The technical and political limitations in applying Agency safeguards.

--The lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material for military purposes or that knowingly supplies material to another country for developing nuclear explosive devices. (See p. 33.)

In addition, the Committees may wish to discuss with executive branch officials the desirability of proposing that the Agency publish annually a report showing, by member country, the amount of nuclear materials subject to its safeguards and the amount and/or percentage of material which could not be accounted for during Agency inspections, while not divulging host country proprietary information. This could help assure all member countries that safeguards are effective and that safeguarded material is not being diverted. (See p. 34.)

CHAPTER 1

INTRODUCTION

On July 30, 1974, the Chairman of the House Committee on International Relations asked that we report to the Committee on a broad range of subjects concerning international agreements for peaceful cooperation in the field of nuclear energy. This report deals with the role of the International Atomic Energy Agency (IAEA) in safeguarding against the diversion of nuclear material for nonpeaceful purposes.

The term "safeguards" within the international context refers to a system of inspection and verification which, when applied to one country's nuclear activities, will provide assurance to other countries that nuclear material is not being diverted for nonpeaceful purposes. The IAEA safeguards are designed only to detect diversions of nuclear material on a national level, and it is assumed that member nations will protect such material from terrorist or subnational groups. The principle of such safeguards is that the risk of early detection and unmasking in the world community will deter a would-be diverter.

IAEA, founded in 1957, is an autonomous intergovernmental organization headquartered in Vienna, Austria. Under the aegis of the United Nations, it is recognized as the agency responsible for international activities concerned with the peaceful uses of atomic energy. This responsibility includes the important function of establishing and administering international safeguards.

IAEA's other functions include exchanging scientific and technical information on peaceful uses of atomic energy; providing assistance to developing countries; and encouraging and assisting research, development, and the application of atomic energy through programs in food, agriculture, and physical and life sciences. It also has a program in nuclear safety and environmental protection. Its programs and activities extend not only to member nations but to cooperation with many international, regional, and national organizations as well.

Membership in IAEA consists of 106 nations. (A list of members is shown in app. II.) The Board of Governors, composed of representatives from 34 member countries, considers policy and recommends budgets and programs to the General Conference. The General Conference, with representatives of all member nations, convenes once a year to debate general policy and to consider recommendations of the Board of Governors. IAEA, headed by the Director General, is organized into five major departments as shown in appendix III. It has 1,100 employees including 350 professional staff members. Of the professional staff positions, 290 are filled according to a geographic selection process. Experts in certain nuclear-related fields fill the 60 remaining positions and serve under special agreements. The United States supplies the largest number of IAEA professional personnel, filling 20 percent of the positions subject to geographic selection.

IAEA funding is primarily derived from assessed contributions and voluntary and special contributions of member nations. Other income is derived from such sources as the sale of publications and excess property and receipts from international organizations and governments for services and technical assistance. Expenditures for calendar year 1974 were about $29.3 million and are estimated to be $35.5 million for 1975. (See app. IV for budget information.)

In addition, IAEA receives assistance-in-kind from member nations in the form of fellowships, equipment, supplies, special nuclear material, films, publications, cost-free experts, and other types of goods and services. It also receives assistance through contracts and other arrangements subsidized by member nations.

Since the inception of IAEA, U.S. financial participation in all categories has amounted to about one-third of IAEA's measurable resources and through 1974 totaled about $76 million. This includes payments of $54.2 million for regular IAEA budget assessments; $10.7 million in voluntary contributions; $9.3 million in gifts-in-kind; $1.1 million in research contracts; and $0.7 million in gifts of special nuclear material.

The U.S. share of assessed contributions has been decreasing steadily since 1960. In 1972 the Congress imposed a 25-percent limit on assessed payments to international organizations. IAEA was exempt from this limitation, in part because of the undesirable effect reduced U.S. funding might have on safeguards. However, in keeping with congressional intent to reduce U.S. obligations to international organizations, the overall share of assessment will be reduced from 31.9 percent ($7,382,611) in 1974 to 28.0 percent ($7,452,741) in 1975. U.S. officials hoped by 1978 to reduce the U.S. rate of assessed contributions on the nonsafeguard portion of the IAEA budget to 25 percent.

The U.S. percentage of voluntary and special contributions is slightly higher than regular assessed contributions, although these rates are also expected to decrease in the future. U.S. voluntary cash contributions in 1973, for example, amounted to about one-third of the total pledges by member nations. U.S. gifts-in-kind in 1973 were estimated at 35 percent of all such contributions.

The United States has provided other types of support. For instance, since 1968 the U.S. Arms Control and Disarmament Agency has awarded about $3.3 million in contracts to U.S. firms for research on safeguards instrumentation and techniques based on the needs developed and identified by IAEA. Other support, such as information and publications made available by the Atomic Energy Commission, 1/ is not readily quantifiable.

The United States was instrumental in establishing IAEA and played an active role in its development. The major U.S. interest in IAEA has been in safeguards. Other IAEA programs in which the United States has strong interests are physical security measures, environmental protection, waste management, and reactor safety.

The United States maintains a small diplomatic Mission to IAEA, which is headed by the U.S. Representative with the rank of Ambassador. The resident staff of the Mission includes a deputy U.S. representative; two officials recruited from ERDA who deal generally with scientific and technical affairs; and two Foreign Service Officers who serve as political advisors and also handle budget and administrative matters.

The Mission protects and fosters U.S. interests in IAEA by recommending policy positions, representing the United States at most nonscientific meetings, assisting the U.S. Representative in conducting relations with IAEA, and informing the Department of State, ERDA, and other U.S. Government agencies of developments within and concerning IAEA. The Mission also maintains liaison with missions and representatives of other IAEA member nations.

SCOPE OF REVIEW

Information for this report was obtained through a review of pertinent records and discussions with officials at the Department of State, the U.S. Mission to IAEA, ERDA, U.S. Arms Control and Disarmament Agency, and IAEA. We visited

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1/The Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission assumed the responsibilities of the Atomic Energy Commission on January 19, 1975.

the IAEA laboratory and a research reactor in Seibersdorf, Austria. We also observed an IAEA inspection of Japanese-owned plutonium being stored in Cheswick, Pennsylvania.

Within IAEA, our review was primarily centered around interviews with officials in the Department of Safeguards and Inspections. Since IAEA does not provide to other member countries the results of its inspections or related documents, on the grounds that host country proprietary information might be disclosed, major portions of our review were necessarily based on discussions.

CHAPTER 5

CONCLUSIONS AND MATTERS FOR CONSIDERATION BY THE COMMITTEE

The real effectiveness of IAEA safeguards is not known. There is no public evidence to show whether IAEA safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes. The mere fact that IAEA has never disclosed a diversion is not sufficient assurance to many countries that IAEA safeguards are effective.

Effective international safeguards depend in large measure on the intent and cooperation of the country to which they are applied and the adequacy of technological control and implementation. However, technological control in the absence of genuine political commitment is inadequate. IAEA officials have stated that safeguards would never be completely effective--they could never be fully confident that no material has been diverted. U.S. and IAEA officials generally conceded that a country could circumvent safeguards if it was willing to assume the risk of detection, incur the expense, and take the trouble to do so.

Although certain technical conclusions can be derived from the safeguards activities, the extent to which IAEA safeguards are effective is largely a matter of judgment. Since IAEA does not disclose to member nations the results of its inspections, on the grounds that proprietary information might be disclosed, it faces the difficult problem of how to assure member nations that safeguards are being applied effectively, fairly, and consistently in all countries.

Membership in IAEA does not obligate a country to accept safeguards on its facilities. For example, the nuclear facilities of major nuclear weapons countries, such as the United States and the Soviet Union, are not subject to IAEA safeguards except on a voluntary basis. In addition, India, Argentina, Egypt, Israel, Spain, Japan, Pakistan, and South Africa are IAEA members with nuclear facilities not subject to IAEA safeguards.

Limitations in the scope and applicability of IAEA inspections must also be recognized. IAEA safeguards are designed only to detect diversions at the national level. IAEA safeguards do not include physical protection, the safe international transport of nuclear material, or the safeguarding of nuclear waste. It does not have authority to seek out undeclared or clandestine nuclear facilities and cannot pursue or retrieve diverted nuclear material.

Mission officials stated that the United States requires safeguards on more export items than those appearing on the trigger list. The United States applies end-use criteria to its nuclear and nuclear-related exports. For example, the United States may require safeguards on equipment which is identified for use in a reactor, as well as equipment for heavy water or reprocessing plants, even though such equipment may also be commonly used in industries outside the nuclear field. Switzerland and France evidently do not use the same criteria because Swiss and French companies are assisting India by supplying equipment and technical expertise to build a heavy water plant, which, when completed, will be unsafeguarded. The plant will allow India to produce its own heavy water, a moderator needed in a natural uranium reactor, which is on the trigger list. The United States also places certain restrictions on technical training and assistance while most other countries do not. These types of self-imposed restrictions could possibly affect U.S. sales.

Mission officials feel that U.S. policies should be adjusted to compare with those of other nuclear exporters and that the United States should guard against being too restrictive as such a policy might cause customers to purchase their nuclear needs from other sources. Mission officials also believe the United States should work jointly with other countries in this area because there is little the United States or any other single country can do unilaterally since no nuclear monopoly exists today.

With the expected spread of peaceful uses of nuclear energy throughout the world, the problems encountered in the administration and implementation of the IAEA safeguards system can be expected to increase. They relate to such matters as:

--The adequacy of material accountability records within the member countries and their compatibility with the IAEA system.

--The continuing need for more advanced measuring instrumentation for inspectors.

--The differences in safeguards agreements with member countries and their interpretation.

--The equitable apportionment of the costs of the safeguards system among member countries.

If IAEA cannot verify the nondiversion of special nuclear material, the country involved is to be given a "reasonable time" to take corrective action before noncompliance procedures may be initiated. Such procedures include notification to member countries and the United Nations Security Council and General Assembly. Continued failure by the country to rectify the situation may also result in the recall of IAEA-sponsored material and technical assistance as well as suspension of membership rights and privileges. By the time these sanctions are made, the country may have had sufficient time to complete its weapons development. It is also not clear how IAEA-sponsored material would be retrieved.

In view of the dangers involved in the spread of nuclear weapons capability, stronger penalties may be needed for those who might violate their pledge to use nuclear material for peaceful purposes.

MATTERS FOR CONSIDERATION BY THE COMMITTEE

The Committee, together with the Joint Committee on Atomic Energy, may wish to pursue with responsible executive branch officials major policy matters related to the role of IAEA, including:

--The need for expanding the responsibilities of IAEA in the physical protection of nuclear material, the control of irradiated nuclear waste, and the safe transport of nuclear materials internationally.

--The technical and political limitations in applying IAEA safeguards.

- --The lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material for military purposes or knowingly supplies material to another country for the purpose of developing nuclear explosive devices.

In addition, the Committees may wish to discuss with executive branch officials the desirability of proposing that IAEA publish annually a report showing, by member country, the amount of nuclear materials subject to its safeguards and the amount and/or percentage of material which could not be accounted for during the inspections, while not divulging host country proprietary information. This could help to assure all member countries that safeguards are effective and that safeguarded material is not being diverted.

Terrorists keep out!

The problem of safeguarding nuclear materials in a world of malfunctioning people

MASON WILLRICH

So far in human history two acts of nuclear violence have occurred in war and none in peacetime. The nuclear explosions over Hiroshima and Nagasaki brought World War II to a rapid end and made all too clear the disastrous consequences if mankind failed to prevent this particular kind of violence in the future.

Since the end of World War II, the governments of a slowly increasing number of nations have tested nuclear explosives, and the United States and Soviet Union in particular have each developed and deployed a vast array of strategic nuclear armaments. Yet governments have managed thus far to avoid acts of nuclear violence. It has not been easy. The leaders of the world's most powerful nations have been preoccupied with the dismal subjects of deterrence, crisis management and arms control, while people in all nations have witnessed, as innocent bystanders, a number of close calls with thermonuclear devastation.

There is substantial evidence to indicate that the relatively few governments which presently possess nuclear weapons go to great lengths to avoid their use in acts of violence. There is no evidence, however, to support a conclusion that either governments of nations, or human beings generally, are less prone to violent behavior than they were before the discovery of nuclear fission. In this respect, a number of trends in the field of terrorism appear especially ominous.

As a working definition of terrorism, I mean threats or acts of violence planned, attempted or carried out by an individual or group with a specific political intent in mind. The incidence of violence initiated by various terrorist groups seems to be increasing in many parts of the world. Moreover, terrorist groups are increasing their technical sophistication, as evidenced by the armaments and tactics they use. Terrorist groups are also developing transnational links with each other in order to facilitate the flow among countries of arms, ammunition and personnel. Finally, in an era of almost instantaneous global communications, whatever works as a terrorist tactic in one part of the world is likely to be picked up and possibly emulated elsewhere.

The recent and abrupt end of an era of cheap oil has propelled the world community into the age of nuclear power. The transition from fossil to nuclear fuel to meet future world needs for electric power is already well under way. Over the past two decades, a number of governments have each spent billions

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of dollars in nuclear power research and development. Electric utilities and equipment manufacturers in several countries have already invested billions of dollars in operational facilities and additional tens of billions are committed to power plants under construction. Nuclear power is presently the only practical alternative to coal and oil for electric power generation.

In light of the 1973-74 Arab oil embargo, and atmospheric pollution resulting from burning coal with existing technology, the need for an alternative is obvious and urgent. And the economic attractiveness of nuclear power, despite rapid increases in capital costs of power reactors, is assured by the fourfold increase in world oil prices dictated by the Organization of Petroleum Exporting Countries (OPEC) cartel. Thus, despite unresolved issues concerning the operational safety of nuclear power reactors, the environmental and radiological effects of large-scale nuclear industrial operations, and the risks of widespread nuclear weapon proliferation, I believe the trend toward nuclear power is irreversible. The basic issue is not whether we use nuclear power, but how to use it wisely.

Key Facts

How, then, does the development of a worldwide nuclear power industry affect the risk of acts of nuclear violence and the problem of preventing such acts? In order to weigh this question, a few key facts must be born in mind.

First, nuclear explosives are relatively easy to make, assuming the requisite fissionable materials are available. Nuclear explosive devices can be made with a few kilograms of plutonium, high-enriched uranium-235, or uranium-233 – a mass of fissionable material about the size of a baseball is enough. The yield of a nuclear explosive device will depend on the quality of the materials used and, most importantly, on the design. The design and fabrication of a simple, transportable, fission explosive is not a technically difficult task.

Second, the effects of a nuclear explosion depend on the characteristics of the device and the target area. A crude, low-yield fission explosive, such as a terrorist group might be capable of constructing, could kill tens of thousands of people and cause hundreds of millions of dollars of property damage in an urban area.

Third, the use of nuclear energy to generate electric power inevitably results in large flows of plutonium, high-enriched uranium, and eventually uranium-233. The light water cooled reactor now in widespread commercial use requires low-enriched uranium fuel, which cannot be used to make a nuclear explosive without further enrichment – a process too complicated and costly for a criminal or terrorist group to perform. However, this type of reactor produces plutonium which could be stolen and used in an explosive after separation at a chemical reprocessing plant and prior to fabrication into fuel for recycling.

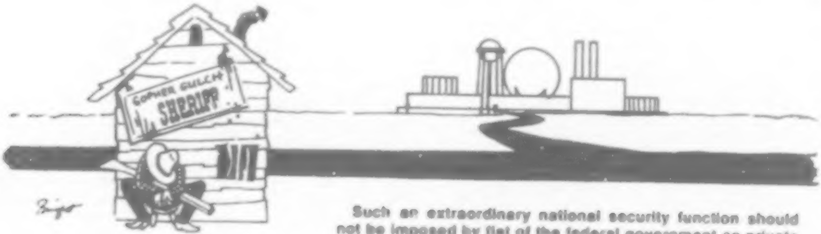
The high temperature gas-cooled reactor now being introduced commercially requires high-enriched uranium fuel which could be used directly in a nuclear explosive, if stolen after the completion of enrichment and prior to completion of fuel fabrication. Moreover, this type of reactor converts thorium into uranium-233 which, like plutonium, could be used in a nuclear explosive after it has been chemically separated from other materials in irradiated fuel.

In the more distant future, and assuming the technology is successfully developed, the sodium-cooled fast breeder reactor will produce more plutonium than it consumes as fuel at the same time that it generates electric power.

In 1974 the Atomic Energy Commission forecasted that in 1980 the U.S. nuclear power industry will use about 19,000 kilograms of materials that could be used directly in nuclear explosives.[1] Worldwide in 1980, nuclear power reactors will be operating in at least 30 countries.[2] Beyond 1980, the number of nations with nuclear power programs will continue to expand and, more importantly, the flows of nuclear explosive materials in countries with large power programs will build up very rapidly.

Where Do We Stand?

Without effective safeguards to prevent nuclear theft or diversion, the development of nuclear power will create substantial risks to the security of nations, the stability of governments and the



Such an extraordinary national security function should not be imposed by fiat of the federal government on private corporations and state and local police.

What is an 'adequate' system of safeguards? And what is an 'acceptable level' of risk of nuclear theft? Such questions should be decided by the public in an open political process.

safety of people in every region of the world. Where then do we stand, in the development of the essential safeguards? A bit of recent history is helpful in answering this question.

The development of safeguards to prevent theft or diversion of strategic materials from the U.S. nuclear power industry was the responsibility of the Atomic Energy Commission until January 1975. Then, in accordance with the Energy Reorganization Act of 1974, the AEC itself underwent fission into the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC). The details of the division of safeguards responsibility between ERDA and NRC are still being worked out.

The matter is complicated by overlaps between safeguards systems applicable to military or classified programs (ERDA's responsibility) and safeguards applicable to the unclassified parts of the nuclear power industry (NRC's responsibility). It is further complicated by interactions between safeguards related to U.S. agreements for peaceful nuclear cooperation with foreign countries (ERDA's responsibility) and the national safeguards system (NRC's responsibility). A major step forward on the safeguards front was made, however, in the internal structure of the NRC. The Act sets up the Office of Nuclear Material Safety and Safeguards as one of the three principal arms of the NRC's staff – the Office of Nuclear Reactor Regulation and the Office of Nuclear Regulatory Research being the other two.

Until AEC requirements were tightened in December 1973, hundreds of kilograms of plutonium or high-enriched uranium could be stored merely in a locked building that was checked by an unarmed watchman only once every four hours. Moreover, enough plutonium or high-enriched uranium for tens of nuclear explosive devices could be shipped across the country simply in an unescorted truck driven by a single, unarmed driver who was not in continuous communication with anyone. These and other glaring defects in AEC safeguard requirements and the prevailing lax attitude within the nuclear industry toward the nuclear theft problem were highlighted in a report by the General Accounting Office to the Congress in November 1973.[3] Thereafter, some of the defects were remedied by regulatory changes.

In early April 1974 a study of safeguards against nuclear theft, co-authored by Theodore B. Taylor and myself, was released by the Ford Foundation's Energy Policy Project.[4] During the course of our year of research it became clear to us that the U.S. government had examined this problem only superficially and sporadically, and that much of the nuclear industry was largely unaware of the seriousness of the risks involved.

One broad conclusion of our study was that "a system of safeguards can be developed that will keep the risks of theft of nuclear weapon materials from the nuclear power industry at very low levels." Such a system would require use of the best available technology and institutional mechanisms. That was the good news. The bad news, however, was that the AEC's current system of safeguards, including the strengthened requirements, was far from adequate. Taken together, the aggregate of existing safeguard requirements do not constitute a system, or a systematic approach, to the problem of preventing nuclear theft.

Prior to publication and release, our study was subjected to an extensive and intensive review process, including comment from the AEC, which we as authors found very helpful. With our draft available, the AEC commissioned a special safeguards study of its own. This was performed by a group headed by an AEC staff member and included a nuclear materials production expert, a nuclear weapons specialist, a nuclear physicist and a former assistant director of the F.B.I. A copy of this in-house study, known as the Rosenbaum report, was pried loose and released by Senator Ribicoff in late April 1974.[5]

The AEC report foresaw the frightening possibility of a rise in "urban terrorist groups in this country. . .likely to have available to them the sort of technical knowledge needed to use the now widely disseminated instructions for processing fissile materials and for building a nuclear weapon. They are also liable to be able to carry out reasonably sophisticated attacks on installations and transportation." The AEC report minced no words in its conclusions: "that the new regulations are inadequate and that immediate steps should be taken to greatly strengthen the protection of special nuclear materials."

Since the publication of the Energy Policy Project safeguards study and the strong confirmation given our findings by the AEC's internal study of the same matter, the Commission's staff issued in August 1974, a four volume draft environmental impact statement, as required under the National Environmental Policy Act, in order to provide a basis for deciding whether and on what conditions to permit the recycle of plutonium as fuel in light water reactors.[6] As an indication of the economic significance of this decision, the energy contained in the plutonium that would be recycled in U.S. power reactors through 1995 is estimated to be equivalent to 10 billion barrels of oil or 2 billion tons of coal.

With respect to safeguards considerations, the AEC's conclusion is that its current requirements will not be adequate. However, the AEC also concludes that if a number of major new concepts are implemented, and if decisions on upgrading the system are taken within about one year after the final impact statement, then the safeguards problem will be "manageable." Hence, if a major upgrading of safeguards does not occur within such a time frame, the risks of nuclear theft and sabotage may, according to the AEC's own analysis, prove to be unmanageable.

In 1974, therefore, the AEC staff appeared to have undergone a major change of attitude toward the safeguards problem. In addition, there has been a growing appreciation among a few members of Congress of the seriousness of the danger and the high stakes involved.

Despite this progress, our nuclear safeguards program remains in danger of being starved to death for lack of funds. Prodded by outside criticism and pushed by the results of its own rethinking, the AEC requested an additional $85 million to upgrade its safeguards effort during Fiscal Year 1975. Of this amount, 80 percent was slashed by the Office of Management and Budget—including the entire amount requested to beef up the AEC's (now the NRC's) regulatory staff in this area. A small portion of the cut was restored by last minute action in the Joint Committee on Atomic Energy.

Our nation's economic difficulties do not justify gambling with the safety of the American people and the security of our governmental institutions from nuclear threats. Therefore, it is to be hoped that adequate funding levels for stronger safeguards will be provided in the Fiscal Year 1976 budgets of ERDA and NRC, which are now under consideration by the Congress. Perhaps more important at this stage than money is a heightened sense of awareness of the safeguards problem and the large stakes in the world's energy future in finding effective and practical solutions. Such an awareness still needs to be instilled at the top levels of government and industry in order that lower levels can do their jobs.

The costs of an effective system of safeguards against nuclear theft would be only a very small fraction of the value of electricity produced with nuclear fuel. Yet the costs of an ineffective system would be immense, not only for the American people but for the entire world community.

Effective safeguards against nuclear theft or sabotage in the United States is only part of a much larger global problem. In order to come to grips with the international issues, however, we must have our own house in order.

Little is publicly known about the efforts in other countries with nuclear power programs to develop and implement their own safeguards to protect against nuclear theft. Yet terrorist organizations are even more of a threat in several of these countries than in the United States. The risk of nuclear theft affects us all since plutonium or high-enriched uranium stolen from the U.S. nuclear power industry could be used in a terrorist attack in some other country, and material stolen in another country could be used by terrorists to hold hostage a city in America.

At International Level

Almost no serious discussion of this problem has occurred at the international level, though there have been a few preliminary technical efforts. The time that national political and industrial leaders have to deal with the problem is rapidly running out, and leadership in this area appears so far to be lacking.

India's detonation of a nuclear explosive using plutonium produced in a reactor obtained from Canada under a 'peaceful uses' guarantee was a substantial setback to international efforts to curb the proliferation of nuclear weapons among governments through the Non-Proliferation Treaty. Regardless of their attitudes toward the acquisition of nuclear explosives by more and more governments, all governments have a common interest in preventing nuclear theft from their own nuclear industries and also from the industries of other countries.

Systems of national safeguards can be developed that will keep the risks of theft of materials for nuclear explosives from nuclear power industries at very low levels. Of course 'zero risk' is an impossibility in this, as in other, dangerous human activities. Yet clearly adequate safeguards should be a condition for the continued development and use of nuclear power. But such statements beg the important questions: What is an 'adequate' system of safeguards? And what is an 'acceptable level' of risk of nuclear theft? These are central political issues that should not be decided in our society by any group of experts, no matter how informed or well intentioned, within government or industry. Such decisions should be made, reviewed, and remade through the pulls and tugs of widely divergent views expressed forcefully, but fairly, in an open political process as nuclear power develops and the social context changes. At the same time, widely differing safeguards positions may be taken by other governments, many of which are based on far different principles from ours. And their domestic safeguards decisions will necessarily affect our security too.

The following summarizes my current thinking concerning the major directions toward which the U.S. safeguards program should be headed in the immediate future in order to provide the American people with adequate safeguards against nuclear theft. The new NRC is already moving, or is seriously considering moving, in these directions, but it still needs encouragement and more sup-

A human problem for which there is no technological fix.

port. The need is especially great at this time for active support and leadership on safeguards issues to come from within the nuclear industry itself. After all, private industry's economic interests would be seriously jeopardized by a successful large nuclear theft.

Safeguards should emphasize the *prevention* of theft and the detection of any theft attempt in time to prevent its completion. Detection of a completed theft, recovery of stolen material, and response to any nuclear threat involving stolen material are important supplementary safeguard functions. The physical barriers and security forces employed should be capable of defeating the maximum credible threat that can be reasonably expected. Within the United States, such a threat might involve an attack by a group of perhaps 10 to 15 persons using sophisticated firearms and equipment. Insofar as practical, instruments and techniques should be developed and used to provide a timely and accurate picture of the material flows in the various nuclear fuel cycles, and to detect immediately the flow of any nuclear explosive materials out of a material access area through an unauthorized channel. After-the-fact accounting methods will be insufficient in view of the quantities of materials involved and the short response time available.

Co-location of nuclear fuel cycle support facilities – enrichment, fuel fabrication and chemical reprocessing – could virtually eliminate the transportation links that are most vulnerable to nuclear theft. In this connection, the Energy Reorganization Act requires the new NRC to undertake a national nuclear energy center site survey.

Furthermore, the possibility of 'spiking' plutonium used in the nuclear power industry that is, leaving sufficient fission products in plutonium that is reprocessed to constitute a lethal hazard to anyone who handles it without massive shielding – should also be seriously considered. Such spiking might reduce the cost of reprocessing, reduce the long-lived radionuclides in radioactive wastes, increase the cost of shipping (if fuel cycle facilities were not co-located), and increase the costs of fuel fabrication. Of course, an advantage of co-location of fuel cycle facilities is that it would reduce the need for measures such as spiking.

Under the existing safeguards approach, each operator of a nuclear facility is responsible for providing a private security force, intended to work in cooperation with local police, to protect nuclear explosive materials at the facility and during transportation. I do not believe such an extraordinary national security function should be imposed by fiat of the federal government on private corporations and state and local police. The private nuclear industry is in the midst of a demanding technological innovation under difficult economic circumstances. Local law enforcement authorities are already overworked, underpaid, and sometimes unable to cope with the present level of conventional violence in society. Despite serious philosophical and practical reservations regarding any real or apparent move in the direction of a police state, I believe we should seriously consider the establishment of a nuclear materials security service as a direct responsibility of the federal government.

Finally, the U.S. government should, as a matter of urgency, pursue discussions with other governments with substantial nuclear power programs in order to develop a common policy concerning safeguards against theft. In 1972, the International Atomic Energy Agency convened a panel of experts which developed recommendations for the physical protection of nuclear material, and the IAEA has since then sponsored some further technical discussions. In 1974 Secretary Kissinger proposed before the United Nations that a treaty be negotiated to provide international standards for physical security of nuclear materials. There will be an opportunity to discuss this subject at the Non-Proliferation Treaty review conference which is convening this month in Geneva. International diplomacy must be speeded up and intensified if adequate safeguards against nuclear theft are to be applied to the burgeoning worldwide nuclear power industry.

In conclusion, emergency core-cooling systems and other safety features built into nuclear power reactors are designed to deal with the risk of malfunctioning machines. Safeguards against nuclear theft and sabotage are intended to deal with the risk of malfunctioning humans. The possibility of nuclear violence using material diverted from civilian industry is fundamentally a human problem for which there is no technological fix. There is no final solution. Nor is there any alternative to dealing with it effectively until the last fissionable atom has been split.

NOTES

1. AEC, Office of Planning and Policy Analysis, *1974 Forecast*, WASH 1139 (Washington, DC: The Commission, 1974).

2. Listed in order of the size of their projected installed nuclear power capacities in 1990 these countries are: United States, Japan, West Germany, United Kingdom, Soviet Union, Sweden, France, South Africa, Canada, Switzerland, Taiwan, Korea, Italy, East Germany, Czechoslovakia, Belgium, India, Argentina, Finland, Mexico, Netherlands, Spain, Romania, Bulgaria, Austria, Brazil, Yugoslavia, Thailand, Philippines, Pakistan.

3. Comptroller General of the United States, *Improvements Needed in the Program for the Protection of Special Nuclear Material*, Report to the Congress (Washington, DC: GAO, Nov. 7, 1973).

4. Mason Willrich and Theodore B. Taylor, *Nuclear Theft: Risks and Safeguards* (Cambridge, Mass.: Ballinger Publishing Co., 1974).

5. D. M. Rosenbaum, J. N. Googin, R. M. Jefferson, D. J. Kleitman and W. C. Sullivan, *Special Safeguards Study*. Excerpts appeared in the Congressional Record, April 30, 1974, p. S6621.

6. AEC, Director of Materials Licensing, Fuels and Materials, *Draft Generic Environmental Statement Mixed Oxide Fuel*, WASH 1327 (Washington, DC: The Commission, Aug. 1974).

April 6, 1976

The Societal Impact of Safeguards

John H. Barton
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(For Presentation to the Atomic Industrial Forum
Conference on Nuclear Safeguards, Orlando, Florida,
April 12, 1976)

You have asked me to speak on the societal impact of safeguards. This impact could be enormous but is very difficult to predict. Careful design and operation of the safeguards systems could drastically reduce their impact,[1/] so this impact first depends on what safeguards systems are actually implemented during the next several years. Later on, unpredictable political pressure in the wake of an actual nuclear terrorist incident might compel the use of safeguards so stringent as to have serious social impact. And the underlying questions are nearly unanswerable: How serious is the terrorist risk? Are stringent safeguards all that useful in preventing terrorist incidents?

It is a necessary - although not a sufficient - condition of proceeding with plutonium recycle that we find a way to keep the civil liberties costs small. I would therefore urge that the civil liberties aspects of safeguards be established politically, preferably by Congressional legislation before the nation becomes economically committed to plutonium recycle. This would permit us to estimate the costs beforehand and would make it harder for us to intensify the safeguards in the future.

To explain this position I will consider three of the most important ways in which safeguards might directly affect our society: clearance procedures, surveillance, and police operations during a terrorist incident. I will review the possible societal risks posed by these safeguards and the way in which legislation might reduce those risks. I will also attempt to suggest manners in which the politics of safeguards might develop.

Clearances.[2]

The number of people covered by a nuclear industry security clearance program would be very small (tens of thousands at most) in comparison with the number of people already covered at one time or another by various federal security clearance programs (over ten million). Thus, a priori, one would expect little social impact from a safeguards clearance program.

There could, however, be key differences between a nuclear security clearance program and the existing programs. First, although NRC is apparently considering a standard comparable to the "Secret" level clearance of the Defense Department, the reliability standards and the intensity of the investigation might eventually correspond to those of only the highest current federal clearance programs. Second, the two kinds of programs are designed primarily to shield against rather different forms of activity -- release of classified data in most current programs compared to sabotage or theft in the nuclear program. Third, current programs are designed to screen out primarily those who might place the interests of a foreign nation above those of the United States. The nuclear safeguards clearance standard would have to place additional emphasis on detecting unstable employees and employees who might act out of opposition to the domestic policies of the United States.

This societal-impact problem is most clearly posed by the standards to be used in granting or denying a clearance: are there standards which are both adequate and consistent with our current social norms? The Supreme Court's approach to the constitutionality of clearance procedures looks to the chilling effect these procedures might have on First Amendment rights, especially on the right of association. A pattern of sympathies, associations and actions in favor of a foreign government can arguably permit denial of a clearance in the traditional defense area. But, aside from evaluation of psychological stability and of likelihood of acting in favor of foreign governments, what is the parallel standard with regard to nuclear theft and sabotage? If one must be very certain that the individual is unlikely to sabotage nuclear industry, it seems hard to avoid considering evidence based on domestic associations and beliefs such as whether or not the individual favors nuclear power. But use of such a test would chill important domestic political discussion and would almost certainly be constitutionally repugnant. If the constitutional doctrine were changed to permit examination of beliefs and associations for clearances in highly sensitive areas such as the plutonium area, it would become very difficult to maintain a line between examination for disloyalty and examination for political dissent in granting other clearances.

An additional concern with clearances is the invasion of privacy. Some persons are likely to find a background investigation offensive, and in violation of emerging concepts of privacy. This concern is likely to be greater in the nuclear security context than in the national security context. There is an important psychological distinction between the two contexts; one would not like to see clearance procedures expand to cover all in the peaceful economy (e.g. airline pilots or mechanics) who might be in a position to cause substantial destruction. One may argue that this privacy interest, although important, is secondary compared to the First Amendment interests since the First Amendment interests go to the shaping of political debate. Although the argument may be persuasive in some contexts where a choice between the two rights must be made, I fear that weakening of the importance of the individual's individual rights could remove a crucial intellectual underpinning of the individual's political rights.

So long as the clearance program uses standards like those of the Department of Defense "Secret" clearance and avoids inquiring into the individual's attitudes towards the nuclear industry, it is almost certainly constitutional, and its effects upon speech and privacy are minimal. Going to more severe standards raises genuine questions about social desirability; you would be wise, therefore, to design the physical security procedures so that more severe clearances are not needed. Moreover, so many doubts have been expressed about the effectiveness of clearance programs that this effectiveness should be evaluated before implementing such a program. Even with a relatively low clearance standard, it would also be wise to apply a background investigation requirement only to those working in sensitive positions.

Surveillance.

It is frequently said that the best defense against terrorism is good police work -- meaning wiretapping, infiltration and surveillance of groups likely to practice terrorism. This possibility of continuing surveillance is probably the most severe political effect of safeguards.

Certainly, the government is already engaged in a substantial amount of domestic surveillance. Surveillance can also be argued to be a necessary response to foreign plutonium production, no matter what the U.S. does about plutonium production. Moreover, the surveillance agencies are said not to distinguish between, for example, high-explosive terrorists and chemical warfare terrorists.

Nevertheless, plutonium recycle would provide a new justification for surveillance; according to some, the only rational justification. Nuclear safeguards requirements would be prominent among the arguments used by surveillance agencies at budget time. Thus, plutonium recycle could be central in helping maintain what might otherwise be a diminishing level of surveillance.

Because of this effect and because of the possibility that the surveillance agencies might overact to the nuclear terrorist threat, it is clear this civil liberties cost must be weighted into any decision on plutonium recycle. The fact that the industry or the NRC may ask other agencies to undertake operational responsibility for the surveillance does not weaken the responsibility to weight the civil liberties costs of that surveillance, to provide these agencies with the information necessary to prevent overreaction, and if at all possible, to create mechanisms to watch the surveillance operations to ensure that overreaction does not occur.

It is reasonable to go further to argue that domestic surveillance is highly questionable, that it can, at most, be allowed within a careful legislative framework and that the safeguards system must simply accept any resulting risks. Surveillance could be very dangerous for First Amendment freedoms and, once legitimized, could be supported as a way to meet many threats other than nuclear power. Our society would be greatly changed. I would therefore argue against the logic that a large domestic risk -- even that of nuclear terrorism -- justifies domestic surveillance beyond our constitutional norms.

Both the clearance and the surveillance areas show the ambiguity I alluded to at the beginning of this paper. The social effects of some safeguards need not be great. But extensive safeguard programs could produce serious social effects, while perhaps yielding little incremental benefit in suppressing terrorism. Legislation could help prevent these extensions.

Society, if plutonium recycle is accepted, would effectively be assuming an increased risk of terrorism for the sake of protecting constitutional liberties. The danger in this position is that the public might sharply reverse itself following a nuclear incident and insist on extremely intensive surveillance thereafter -- but the legislation would be a barrier to easy extension of the programs.

Nuclear Incidents.

Strictly speaking, the social effects of nuclear incidents are less problems of safeguards than they are problems of the failure of safeguards. Moreover, the immediate effects of an incident on those who might be killed and on their survivors may outweigh long-term "societal effects" -- but these societal effects do need to be considered. Several specific areas deserve discussion.

The first is the use of deadly force by guard or reaction forces. State and federal law both restrict the right of the guard or reaction forces to "shoot to kill". The content and difficulty of these restrictions have often led to ambiguity or restraint in the orders issued to private guards. And the availability of both legal and practical defenses for public officers has generally left these officers more willing to use deadly force than are private guards.

The key way to reduce social impacts in this area is to determine the minimum effective level of force use and the most appropriate tactic for the different kinds of guards. Too sharp or too weak a response could lead to unnecessary bloodshed. In general (and with many variations), as one moves along the spectrum from private guards through federal guards towards military units, the level of discipline is perhaps likely to increase, but the forces' natural tactics are perhaps likely to become increasingly inappropriate. This area is one where legislation plays a secondary role. Tactical doctrines, career patterns, training patterns, and centralization or decentralization of management are much more important.

Even if the most careful efforts are made to prevent misuse of force, there are clear costs associated with increasing the number of armed forces in the society. For example, the actions of response forces and perhaps of transportation guards are likely to resemble small-unit military engagements rather than traditional police activity. This extension of the role of a police force in the society ought to be clearly understood by the public.

The search for a quantity of stolen plutonium or for an individual who is suspected of having stolen it is another problem area. Such a search, with or without a warrant, does not come within the rationale of existing law, which holds that the "public interest would hardly justify a sweeping search of an entire city conducted in the hope that [specific stolen or contraband] goods might be found."[3] Yet, precisely that search might be contemplated in the case of a plutonium loss, or even in the case of an inventory shortage, at least when technical devices do not permit search from the street or from office building corridors. The search would be criminal in nature, and, given the possible time pressures, might be both intrusive and destructive.

It is therefore quite possible that even in a nuclear emergency, such a search would be struck down by the courts. Nevertheless, in the airport search cases, a perceived overwhelming necessity dictated a change in the law. And public opinion would probably support such a change in the law. If the courts were to expand existing exceptions to permit area searches during nuclear emergency, the implication could be much greater freedom for area searches in any riot or terrorist blackmail situation, and, in fact, a generally increased government search power.

Finally, dissidents might be seized and detained after a plutonium theft. Detention could be justified as a way to isolate and immobilize persons capable of fashioning the material into an explosive device. Conceivably, detention could also be used as a step in a very troubling interrogation scheme — perhaps employing lie detectors or even torture. The normal deterrent to such practices — inadmissibility of evidence in court -- would be ineffective under the conditions of a nuclear emergency.

I would argue that the third-degree methods -- impermissible even in military combat -- are illegal and unconstitutional. However, detention of persons potentially capable of crime has been upheld in three unusual types of circumstances: (1) relocation of alien and U.S. Japanese citizens on the Pacific Coast early in World War II, (2) denial of bail to aliens pending their appeal of deportation proceedings if the aliens are threats to the national security, and (3) Presidential protection. Precedents are therefore available to support a possible judicial decision to uphold almost any detention reasonably designed to help recover stolen plutonium. But in the process, an authority previously applied primarily to help protect against a very limited range of threats would be extended. A new absolute, nuclear material protection, would be added to the existing absolutes, such as Presidential protection and passenger aircraft protection, which are allowed to override normal constitutional guarantees. The chilling effect on political debate could be substantial and a sense of public polarization against potential terrorists intensified. One wonders how many exceptions are possible before the exceptions shape the rules. The public — and the government as well, as shown this winter, can look back on the Japanese detention during World War II and recognize that it was an error, perhaps understandable under the pressures of the time. Societies ravaged by war have often successfully restored their political structure. It may, however, never be possible to gain the same psychological distance from a nuclear emergency.

Although the arguments are somewhat more balanced than for legislation governing routine safeguards, legislation defining any extraordinary powers to be used during a nuclear emergency should be considered. Such legislation might restrain abuse during the emergency and restrict the legal and political swap of the justification for any special powers. Legislation might, on the other hand, however, make it easier to obtain public and even judicial support for further legislation weakening constitutional guarantees under other less extreme conditions. Whether or not legislation for emergencies is desirable, broad discussion of the emergency issue is certainly desirable. Such discussion can help local organizations prepare for emergencies and can widen the input to decisions that should not be left either to the industry alone or to local police organizations acting under emergency pressures. The discussion can also provide a psychological preparation that might decrease the long-term negative social impacts of a nuclear terrorist incident.

The existence of safeguards and of plutonium recycle itself might finally weaken civil liberties indirectly through an effect on political attitudes. I am inclined to some extent to discount this effect. A general public move against dissent is probably more likely to derive from reactions to events outside the nuclear area than from reactions to events within the nuclear area. These public moods follow a dynamic of their own -- a dynamic usually more closely coupled to underlying political and social change than to the details of specific technologies. Likewise, the level of terrorism is also probably much more dependent on political and cultural factors such as attitudes towards authority, than on the availability of a specific terrorist means. Thus, it may be that the presence of plutonium and of safeguards would, at worst, accentuate some otherwise unassociated political trend towards increased repression.

Nevertheless, a credible argument can be made in the opposite direction. There is a coupling between public attitudes towards nuclear power and public attitudes towards terrorism. In spite of the arguments that a nuclear terrorist might be wiser to steal a weapon from the military than to steal raw materials from a reprocessing facility, a plutonium recycle decision does increase the opportunity for terrorism. Hopefully, this resulting public concern about nuclear terrorists would not spread to support intrusive measures against other targets: non-nuclear terrorists, criminal conspiracies generally, and even dissenters from technological progress. The nuclear case is a very special one with a mystique derived from energy's relation to lifestyle and from the nuclear weapon itself. Even though the threat of a liquified natural gas explosion, for example, may be comparable to that of a nuclear explosion, it is difficult to imagine the public reacting to a chemical terrorist the way it would to a nuclear terrorist. Perhaps concern over safety against criminal activity probably runs deeply and could perhaps be triggered by a nuclear incident. The current concern over government invasion of privacy could be a weaker political phenomenon. Early incidents of nuclear terrorism or sabotage -- whether or not successful -- might increase political support for termination of the nuclear power program, rather than for very intense safeguards. Later on, as the society became more committed to nuclear power, incidents would almost certainly lead to public support of intensified safeguards, just as incidents of aircraft hijacking and attempted assassinations have increased support for parallel protective systems in spite of the effects of these protective systems on civil liberties.

Further, the groups which have traditionally defended civil liberties may tend to press less sharply in the nuclear safeguards area than in other areas. Nuclear safeguards and the entire nuclear terrorism issue have become significant in the nuclear power debate; those most troubled about nuclear power are often the same as those usually most outspoken in the protection of civil liberties. In making the recycle decision, the nuclear power politics of nuclear terrorism have dominated the possible civil liberties politics of nuclear safeguards. After that decision is taken, it may be hard for those who pointed to the nuclear terrorist threat as an argument against nuclear power to change their grounds and to help protect the public against safeguards that infringe civil liberties.

Obviously, these political factors are all intangible and unpredictable. The U.S. politics of safeguards may be shaped less by decisions within the U.S. than by decisions abroad. Moreover, there is a plausible social risk in slowed economic growth -- although this risk is one that may be presented to us by some other resource or environmental limitation no matter what decision is made on plutonium recycle. But plutonium safeguards present civil liberties risks, too. You may be able to reduce the sharpness of the tradeoff between civil liberties and terrorism through dilution techniques, physical barriers, or collocation of plants. Even with such technical procedures, however, we would be wise to obtain early legislation which places civil liberties limitations on safeguards. After binding ourselves to an acceptable safeguards system, we can decide whether the terrorist risks of plutonium recycle are worth accepting.

FOOTNOTES

1. *See* W. Clune, *Standards and Decision Rules for Evaluating Trade-Offs Between Civil Liberties and Nuclear Materials Safeguards*, (Report to the NRC, October 31, 1975).

2. For contrasting and more extensive views on the different substantive areas discussed here, see R. Ayres, "Policing Plutonium: The Civil Liberties Fallout," 10 *Harv. Civ. R.-Civ. Lib. L. Rev.* 369 (1975); Bartkus & Block, *Rapporteur's Report, Conference on the Impact of Intensified Nuclear Safeguards on Civil Liberties*, (Report to the NRC, October 31, 1975); J. Barton, *Intensifed Nuclear Safeguards and Civil Liberties*, (Report to the NRC, October 31, 1975); Dyk, Marcus and Kolasky, *Civil Liberties Implications of a Safeguards Program for Special Nuclear Materials in the Private Nuclear Power Industry*, (Report to the NRC, October 31, 1975); and F. Wyle, *Plutonium Recyclying, Safeguards, and Civil Liberties*, (Memorandum for the NRC, December 1, 1975).

3. Camara v Municipal Court, 387 U.S. 523 (1967).

* Parts of this talk are based on a report to the NRC, *Intensified Nuclear Safeguards and Civil Liberties*, October 31, 1975, prepared under Contract No. AT(49-24)-0190, with the assistance of R. Bartkus, G. Block, and J. Owens. I am, however, solely responsible for the contents and am in no way speaking for the NRC, or for Stanford University.

EXPORT REORGANIZATION ACT OF 1976

HEARINGS

BEFORE THE

COMMITTEE ON
GOVERNMENT OPERATIONS
UNITED STATES SENATE

NINETY-FOURTH CONGRESS

SECOND SESSION

ON

S. 1439

TO REORGANIZE CERTAIN EXPORT FUNCTIONS OF THE FEDERAL GOVERNMENT TO PROMOTE MORE EFFICIENT AND EFFECTIVE ADMINISTRATION OF SUCH FUNCTIONS

JANUARY 19, 20, 29, 30, AND MARCH 9, 1976

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TESTIMONY OF J. KENNETH FASICK, DIRECTOR, INTERNATIONAL DIVISION, U.S. GENERAL ACCOUNTING OFFICE, ACCOMPANIED BY EARL G. WOODS, ASSISTANT DIRECTOR, INTERNATIONAL DIVISION, U.S. GENERAL ACCOUNTING OFFICE AND JOSEPH MURRAY, SUPERVISORY AUDITOR, INTERNATIONAL DIVISION, U.S. GENERAL ACCOUNTING OFFICE

Mr. FASICK. Mr. Chairman and members of the committee, at your request, we are here to discuss our July 1975 report on our review of the role of the International Atomic Energy Agency in safeguarding nuclear material. The review leading to our report was undertaken at the request of the chairman, House International Relations Committee.

The rapid growth of nuclear power as a source of energy has focused considerable attention on the proliferation of nuclear material and the potential diversion of this material from peaceful activities to the development of nuclear explosive devices.

755 POWER REACTORS WORLDWIDE BY 1990

It has been estimated that by 1980, the number of power reactors in IAEA member countries will increase from the 1974 level of 182 (with a capacity of about 72,000 megawatts) to about 400 (with a capacity of about 263,000 megawatts). An IAEA survey estimated the market for nuclear power reactors in developing countries between 1981 and 1990 would amount to an additional 355 units with a total capacity of 220,000 megawatts.

Nuclear power reactors in use throughout the world today are fueled with either natural or slightly enriched uranium. After such uranium has been used to fuel a reactor for about a year, plutonium is produced as a byproduct in the spent fuel which is recoverable through chemical reprocessing. Only plutonium and highly enriched uranium are suitable to making nuclear explosives. Between 5 and 10 kilograms of plutonium or between 20 and 30 kilograms of highly enriched uranium are needed to make a nuclear explosive device.

To detect any diversion of U.S.-supplied nuclear material which might be used for other than peaceful purposes, the United States initially established bilateral safeguards under its individual agreements with foreign governments for cooperation in the civil uses of atomic energy. However, since the inception of the IAEA, the United States has almost completely phased out its bilateral program in favor of international or IAEA safeguards.

IAEA, founded in 1957, is an autonomous intergovernmental organization headquartered in Vienna, Austria. Under the aegis of the United Nations, it is recognized as the agency responsible for international activities concerned with the peaceful uses of atomic energy. This responsibility includes the important function of establishing and administering international safeguards.

The term "safeguards" within the international context refers to a system of inspection and verification which, when applied to one country's nuclear activities, will provide assurance to other countries that nuclear material is not being diverted for nonpeaceful purposes.

The 106 member countries of IAEA include all nations with significant amounts of nuclear activity, except the People's Republic of China and the Republic of China (Taiwan). The latter's nuclear facilities, however, are subject to IAEA safeguards.

However, membership in the Agency does not obligate a country to accept safeguards on its facilities. For example, nuclear facilities of major nuclear weapons countries, such as the United States and the Soviet Union, are not subject to agency safeguards except on a voluntary basis. In addition, India, which exploded a nuclear device in 1974, along with certain other IAEA member nations, has nuclear activities which are not subject to agency safeguards.

LIMITATIONS OF IAEA SAFEGUARDS

The Agency's safeguards system consists of material accountability, onsite inspections, and surveillance and containment devices such as cameras and seals. The principle is that the detection capacity of the system will deter a would-be diverter. However, limitations in the scope and applicability of inspections must be recognized.

Agency safeguards are designed only to detect diversions on the national level, and it is assumed that member nations will protect nuclear material from terrorist or subnational groups.

Agency safeguards do not include physical protection, the safe international transport of nuclear material, or the safeguarding of nuclear waste.

The Agency does not have the authority to seek out undeclared or clandestine nuclear facilities and cannot pursue or retrieve diverted nuclear material.

The desired effects of IAEA safeguards are to (1) deter, through prompt detection, national diversions of safeguarded nuclear material; (2) place responsibility on the country for instituting domestic programs to guard against subnational diversion of safeguarded nuclear material (i.e., by individuals or groups acting contrary to government policy); (3) reduce specific international tensions by providing a degree of assurance among countries, especially hostile neighbors, that the safeguarded country is not developing nuclear explosive devices; and (4) insure that international nuclear commerce can be freely conducted without contributing to insecurity and tension among nations.

BETTER INSTRUMENTS, MORE STAFF NEEDED

IAEA hopes to apply safeguards with a high degree of reliability and assurance, within acceptable cost limits and without unduly interfering with commercial operations. At the present time, the challenges to safeguards are great, rapid growth is expected in nuclear facilities throughout the world, and IAEA will be tasked to respond. Instrumentation and techniques will need to be developed and refined. Adequate numbers of qualified staff will need to be recruited, and political solutions and compromises with participating nations and facility operators will be needed.

Although IAEA is working diligently in the safeguards area, problems do exist and will probably continue to develop. They relate to such matters as:

Adequacy of material accountability records within the member countries and their compatibility with the agency's system.

Continuing need for more advanced measuring instrumentation.

Equitable apportionment of costs of the safeguards system among member nations.

Obtaining and training qualified inspectors.

Differences in safeguards agreements with member countries and their interpretation.

It would be difficult if not impossible to prove whether or to what degree safeguards actually accomplish the desired effects. Although certain conclusions can be derived from safeguards activities, the extent to which the safeguards are effectively applied is largely a matter of judgment.

INSUFFICIENT ASSURANCE AGAINST DIVERSIONS

In our opinion, the real effectiveness of Agency safeguards is not known. There is no public evidence to show whether Agency safeguards have prevented or detected diversion of nuclear material from intended peaceful purposes.

The mere fact that the Agency has never disclosed a diversion is not sufficient assurance for many countries that the safeguards are effective.

Effective international safeguards depend in large measure on the intent and cooperation of the country to which they are applied and the adequacy of technological control and implementation.

U.S. and Agency officials generally conceded that a country could circumvent safeguards if it was willing to assume the risk of detection, incur the expense, and take the trouble to do so.

Since the Agency does not disclose to member nations results of its inspections, on the grounds that proprietary information might be disclosed, the Agency faces the difficult problem of how to assure member nations that safeguards are being applied effectively, fairly, and consistently in all countries.

IAEA PROCEDURES SLOW, UNCLEAR

If the IAEA safeguards inspectors cannot verify the nondiversion of special nuclear material, the country involved is to be given a reasonable time to take corrective action before noncompliance procedures may be initiated. Such procedures include notification to member countries and the United Nations Security Council and General Assembly. Continued failure by the country to rectify the situation may also result in the recall of IAEA-sponsored material and technical assistance as well as suspension of membership rights and privileges. By the time the sanctions are made, the country may have had sufficient time to complete its weapons development. It is also not clear how IAEA-sponsored material would be retrieved.

In view of dangers involved in the spread of nuclear weapons capability, stronger penalties may be needed for those who might violate their pledge to use nuclear material only for peaceful purposes.

ADVANTAGES OF IAEA SAFEGUARDS

There has been some question as to whether U.S. interests are best served through bilateral or IAEA safeguards. There are advantages and disadvantages to both. U.S. officials have outlined the following advantages to IAEA safeguards:

IAEA safeguards may be viewed globally as more credible than bilateral safeguards, particularly in instances where the supplier and the recipient are close allies.

IAEA safeguards would be more uniform and thus would minimize discriminatory application. If several supplier countries had bilateral safeguards systems, effective application might well be reduced to the least strict system.

Safeguards applied by an international organization can serve as an important precedent for international inspection for any future disarmament agreement.

It would be more expensive, in the aggregate, for many supplying countries to establish duplicative inspection systems than for one international organization to undertake the job.

Relying upon IAEA to carry out the safeguards function enhances its prestige and increases its responsibilities and thereby makes it a more effective instrument in all of its fields of endeavor.

Because of costs and technical manpower limitations, many supplying countries would find it difficult, if not impossible, to undertake bilateral safeguards on nuclear materials which they supply.

ADVANTAGES OF BILATERAL SAFEGUARDS

On the other hand, IAEA and U.S. officials advised that in certain instances a supplier country might be in a position to negotiate stronger safeguards provisions bilaterally than IAEA. This is particularly true when the supplier country is a primary or sole source as it may be able to override any restrictions or limitations desired by the recipient country on safeguards application. However, as more countries become exporters of similar nuclear commodities, suppliers may become reluctant to put themselves at a commercial disadvantage by requiring too stringent safeguards.

The obvious advantage of the bilateral safeguards system is that the supplier would have more confidence in an inspection or system which it controlled than in the efforts of others. Bilateral safeguards provide the supplier with greater assurance that material it supplied is not diverted but provide no assurance on materials supplied by others.

IAEA INSPECTION REPORTS NOT AVAILABLE TO THE UNITED STATES

According to a State Department official, a supplier, even one like the United States that has transferred its bilateral safeguards responsibilities to IAEA, can get few details of the precise status of materials supplied because IAEA inspection reports are not made available to the supplier. Politically, however, U.S. officials believe that IAEA safeguards are preferable.

It is difficult to compare IAEA and U.S. bilateral safeguards because, (1) most of the U.S. experience in international safeguards was gained during the formative years and dealt primarily with research reactors, (2) the United States subsequently assigned the majority of its bilateral safeguards responsibilities to IAEA, and (3) the U.S. experience applied, for the most part, to the types of reactors and equipment which were produced and exported from the United States, whereas IAEA safeguards apply to foreign as well as U.S. types of reactors and equipment. With assistance from certain member nations, IAEA is advancing the state of the art in safeguards.

MATTERS FOR CONGRESSIONAL CONSIDERATION

The committee, together with other appropriate committees of the Congress, may wish to pursue with executive branch officials major policy matters related to the role of the Agency, including:

The need for expanding Agency responsibilities in the physical protection of nuclear material, control of nuclear waste, and safe transport of nuclear materials internationally.

The technical and political limitations in applying Agency safeguards.

The lack of sufficiently strong penalties or sanctions on a country that diverts nuclear material for military purposes or that knowingly supplies material to another country for developing nuclear explosive devices.

In addition, the committee may wish to discuss with executive branch officials the desirability of proposing that the Agency publish annually a report showing, by member country, the amount of nuclear materials subject to its safeguards and the amount and/or percentage of material which could not be accounted for during Agency inspections, while not divulging host country proprietary information. This could help assure all member countries that safeguards are effective and that safeguarded material is not being diverted.

Mr. Chairman, that completes my summary of our report on the role of IAEA in safeguarding nuclear material. We will be pleased to respond to any questions you may have.

Senator GLENN. Thank you very much, Mr. Fasick. That is an excellent statement. You did a great job on the GAO report and raise some important questions.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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Remarks of Victor Gilinsky, Commissioner
U.S. Nuclear Regulatory Commission
AIF Conference on Nuclear Safeguards
Orlando, Florida
April 12, 1976

SAFEGUARDING THE FUEL CYCLE

Mr. Chairman, members of the Forum, I am pleased to have the opportunity to talk to you about nuclear material safeguards, both domestic and international. The adequacy of safeguards in general has become a matter of public controversy, and understandably there is interest, and even some apprehension, about the direction in which they are moving.

As you are aware, the Nuclear Regulatory Commission, during its short life, has assigned an increasing priority to the problem of safeguards, and I should like to share with you my personal views on this subject.

For over a year now, an enlarged NRC safeguards staff has worked intensively gaining valuable practical experience with the numerous potential difficulties of controlling and protecting large quantities of plutonium and highly enriched uranium. This effort will of course be reflected in the safeguards portion of the Commission's Environmental Statement on the use of mixed oxide fuel in light water reactors later this year. The Security Agency Study mandated by Congress and addressing itself primarily to the question of whether guard forces at nuclear plants should be federalized will be available shortly. In addition, we have been working out policies and procedures for carrying out our responsibilities for the regulation of U.S. nuclear exports pursuant to the Energy Reorganization Act.

You will hear the details of these various activities from a number of NRC speakers. In these remarks I should like to touch on the outlines of our safeguards program and indicate my own views on some underlying questions -- particularly those arising out of the complex and delicate policy decisions we are confronting in the application of international safeguards.

DOMESTIC SAFEGUARDS

It might be useful to start with domestic materials safeguards and some basic facts about the dimensions of the problem -- the number of facilities and amounts of materials requiring protection. At the moment, "strategic" quantities of plutonium and highly enriched uranium are lodged in 16 licensed facilities, with total inventories, on an average day, of perhaps half a ton of plutonium and over 20 tons of highly enriched uranium. Little of this material relates directly to civilian nuclear power generation. About 95 percent of the highly enriched uranium is government-owned and is intended for naval fuel; the other five percent is mostly HTGR fuel, privately-owned, and much of it in storage. About 50 percent of the plutonium is also government-owned. Each year, approximately 200 shipments of these two materials are made, mostly by land. These numbers will of course increase substantially should the decision be taken to proceed with wide-scale plutonium recycle, and the ratio of government to private ownership will shift markedly.

Upgrading Safeguards

In order to assess the impact of widespread use of mixed oxide fuels on safeguards, the NRC safeguards staff, starting early this year, went into the field for a comprehensive first hand look at safeguards practices in fuel cycle installations, and the situation they found can at best be characterized as less than optimal. In consequence, substantial upgrading in protective measures for nuclear materials at these sites and in transit -- against both theft and assault -- has been undertaken. This program of increased protection is being carried forward in cooperation with the Energy Research and Development Administration, which owns most of the safeguarded materials. Successful completion of this program has been assigned the NRC's number one safeguards priority, and we expect it to be completed by this summer.

We are concerned not only with theft by force but also with surreptitious theft. The latter is especially difficult to counter, because thieves are aided by the fact that it is extremely difficult to keep track of these strategic materials with the precision necessary to provide confidence that inventories have not been dipped into. By comparison, protection against assault on a fixed site or transport vehicle is a reasonably straightforward proposition. The elements of such protection derive from barriers, physical security devices, and guards, and it seems possible to design physical security measures against assault to any desired level.

Because certain physical security measures -- for example, access controls, material detection alarms, and so on -- also play an important role in guarding against surreptitious theft as well, and upgrading of such measures can be readily accomplished, we have concentrated our current upgrading efforts on these safeguards. This approach leaves us, admittedly, with substantial technical difficulties in improving material inventory controls, and therefore with some residual uncertainty. Existing facilities, some of them rather old, were simply not designed to accommodate frequent, accurate inventories; fortunately, there are not very many of them.

In my view, however, accurate accounting plays a key role in combatting theft, and while increased physical protection will compensate in part for the limitations of material inventory systems in plants operating today, we need the assurance that comes from knowing how much material is on hand, in addition to the assurance that comes from knowing that security has not been breached. Efforts to develop the requisite material accounting technology -- ultimately to permit accurate frequent accounts -- must be given high priority.

EXPORT SAFEGUARDS

Materials accounting plays an even more important role in the international arena, where the threat that nuclear materials will find their way into explosives comes not only from private groups but, more importantly, from governments themselves. Here, and let me reiterate that I am expressing my personal views, the question is becoming not whether accounting methods are sufficiently precise, but whether inventory controls alone, no matter how exact, constitute an adequate safeguards program in the emerging technological environment. The reason for this is the appearance in the marketplace of fuel reprocessing, which has added a measure of ambiguity to the heretofore relatively benign export trade in reactors and low-enriched uranium.

Up to now access to appreciable amounts of separated plutonium has been limited, with few exceptions, to a small number of industrially advanced nuclear states. Fuel reprocessing activities have been restricted to an even smaller number, mostly in connection with military programs. Now, however, many countries in varying stages of nuclear development are expressing interest in acquiring facilities to separate plutonium, and in some cases, to separate plutonium from U.S.-supplied fuel.

This creates a safeguards dilemma. On the one hand, the worldwide expectations associated with the development of nuclear power have included the eventual acquisition of indigenous fuel reprocessing facilities. On the other hand, we have only recently come to realize the full safeguards implications of the acquisition of such facilities. It is now clear, at what is perhaps the eleventh hour, that their spread may frustrate international efforts to create sound institutions and effective instruments to protect against possible misuse of civilian plutonium stocks.

Are Assurances Alone Enough?

Under U.S. Agreements for Cooperation, and as required by the Nonproliferation Treaty, all U.S. nuclear exports are covered by assurances that nuclear materials and equipment will be used only for peaceful purposes. But commonsense and a respect for realities dictate that where our vital security interests are at stake, assurances must be reinforced by effective safeguards. Indeed, this has been U.S. policy from the outset. To borrow a phrase from reactor regulation, the system of assurances and backup safeguards was designed to provide "defense-in-depth." The development of international material accounting safeguards schemes was predicated on the assumption that the necessary extra margin of security can only be achieved by a system which provided early warning of materials diversion.

The President has clearly underlined this point in his "Report to the Congress Regarding Laws and Regulations Governing Nuclear Exports and Domestic and International Safeguards" of March 1975. The Report states that the objective of the International Atomic Energy Agency material accounting and verification programs is "the prevention of national diversion of nuclear material from peaceful application by the risk of early detection." It is the risk of being discovered after breaking an agreement but well before attaining the purpose of such a breach -- nuclear explosives -- which provides added confidence that nations will not violate their assurances in the first instance.

This system works as intended where only reactors and the low-enriched uranium which fuels them are involved because it takes a considerable time to divert and secretly extract the plutonium needed for an explosives program. In these circumstances the safeguards system can reasonably be counted on to provide valuable time for a response aimed at controlling the danger.

Direct access to separated plutonium, on the other hand, collapses the lead time to produce nuclear warheads. An expansion of the number of states possessing stockpiles of separated plutonium and thus a near-term nuclear option is a matter of vital concern. A situation in which many states are technologically poised to manufacture nuclear warheads, even if these weapons are inferior by U.S. standards, will inevitably contribute to worldwide tension. If the political restraint on such a supercritical international system should then fail, the repercussions could be sudden and extensive. If one state should then choose to arm itself with nuclear weapons a chain reaction of similar decisions may be triggered. A way must be found to avoid this eventuality, and it must be found before the danger is full blown.

How Much Warning Time?

It is sometimes argued that the collapsed time frame I have described presents no new problems because international response can be counted on to follow diversion promptly. There are, however, flaws in this reasoning. For one thing, a diversion is not likely to be self-announcing, and to assume that it will be does not take account of inevitable ambiguities in ascertaining the facts. For example, is the barring of inspectors from a plutonium storage site, for, say, radiological health reasons, legitimate or merely a cover for clandestine activities? If the latter, detection of the diversion may come a little late. The difficulty of interpreting intelligence has led in the past to historic surprises -- and sometimes catastrophe. The true alarm, if it ever comes, may follow many false alarms and may fail to trigger the expected response quickly. Distinguishing signal from noise takes precious time and, where suitable early warning is lacking, conversion to weapons may be largely complete before diversion from stockpiled plutonium is clearly established.

More important is that the purpose of early warning safeguards goes beyond providing time for the exporter and the world community to react. It also reassures neighbors, who without the confidence of an advance signal might otherwise feel compelled to develop a ready nuclear weapons option in self-defense.

Ineffective safeguards, which cannot be counted upon to provide such warning, will breed desire for ready nuclear options, inflaming an already dangerous state of affairs.

The only way I can see to avoid this situation is to insist that a strict test of effectiveness continue to be applied to safeguards. And reliable early warning is indispensable. Whatever inconsistencies there may have been in this regard in the past, they cannot now justify relaxing the early warning criteria for sensitive fuel cycle technologies.

In drawing attention to the emerging risks in the safeguards picture I do not intend to depreciate the value of IAEA's current efforts in material accounting and inspection. They are an essential minimum for safeguarding fuel cycle facilities, and deserve our continued unstinting support. But we must be very clear about what they can and cannot do in light of today's shifting technological setting.

Looking to the near future, if countries want to exercise what they consider to be their right to separate plutonium produced from safeguarded fuel, how can suitable safeguards be provided? As I have noted, traditional international safeguards -- that is, material accounting and audit inspection -- cannot in my view provide detection which is "early" enough where reprocessing or fuel fabrication are involved. Accordingly, I believe we must seek the application of steps outside the classic systems of safeguards, steps which will physically delay, or at least greatly complicate attempts at diversion. A great deal of serious -- I might even say desperate -- thought is being given to the problem, in other governments as well as our own. Several solutions have been proposed, and some attempted:

- international understandings among suppliers to exercise restraint in their nuclear trade; also,

- cooperative participation in fuel cycle activities with the aim of assuring reliable fuel supplies to all as a trade-off for indigenous and independent fuel cycle facilities; and

- regional, internationally safeguarded, storage sites for spent fuel elements, or their repurchase by the supplying nation.

It is clear that many of these ideas are technically difficult and politically complex. There are many who feel that what is needed now, above all, is a period of delay in separation of plutonium for civilian use, pending development of effective international controls. It is argued that a slowdown is at least possible of accomplishment, and, given the technical state of the art, would not impose unwarranted economic penalties in the immediate future.

Precisely what the United States should do in the face of these new problems has been the subject of considerable controversy. Some have called for the adoption of extreme solutions, such as a total embargo on all U.S. nuclear exports. At the opposite extreme are those who claim that the prevention of further proliferation of nuclear weapons is a hopeless proposition, and that any action taken is futile.

It has been said, moreover, that any increase in U.S. nuclear export controls will merely result in undermining our competitive position with a resulting loss in balance of payments and a further erosion of our ability to influence the application of safeguards. I must say that the history of U.S. efforts to prevent the proliferation of nuclear weapons suggests that despite mistakes that goal has always come first, and here it is worth noting that our participation with the supplier nations in seeking a solution took place at a time when our competitive position was under strong challenge from those very nations. The recent decision by South Korea to forego its planned purchase of a reprocessing plant was another hopeful sign.

The United States must continue to take a strong lead in international safeguards. Obviously, the effectiveness of our actions depends strongly on our acting in concert with other nations. But it does not follow that this nation has no vital obligations in this area beyond what other nations are prepared to agree to beforehand. The responsibility of the leader is to lead.

It has always been assumed that international development of this vital energy source can be made consistent with the constraint that U.S. nuclear export activities not contribute to the further spread of nuclear weapons. We must continually reexamine this assumption to ensure that these goals remain compatible.

I believe that the continued international development of nuclear energy will require us to circumscribe more strictly the fuel cycle activities associated with our nuclear exports. The United States has, indeed, already adopted additional precautions in relation to some prospective Agreements for Cooperation. There appears to be no other way to sustain the standard of safeguards which the American people and other countries have been led to expect.

The Secretary of State

DEPARTMENT OF STATE · UNITED STATES OF AMERICA

Statement

March 9, 1976
Washington, D.C.

Bureau of Public Affairs
Office of Media Services

NUCLEAR NONPROLIFERATION

Secretary Henry A. Kissinger before the Senate Committee on Government Operations.

I welcome this opportunity to speak to you on the subject of nuclear proliferation—one of the most urgent problems facing the United States and the world community and one which will vitally affect the security of all nations for the rest of this century.

As the committee is aware, your concerns over the dangers posed by further nuclear proliferation are widely and deeply shared throughout the U.S. Government.

To convey to you both the seriousness with which we view this issue and the steps we are taking to deal with the proliferation problem, I propose to address the following questions in my statement:

- First, how does nonproliferation fit into the framework of our overall foreign policy?
- Second, what multilateral efforts to deter proliferation have already been initiated and what further measures do we contemplate?
- Third, what actions are we taking as a matter of U.S. national policy to reinforce and extend our international nonproliferation activities?
- Fourth, how do we assess the longer term prospects for containing further nuclear spread through an evolving diplomatic and technical strategy?

IAEA Safeguards. Another essential feature of our international strategy—and, indeed, one that underpins the progress we have made in consultations with other suppliers and one that is basic to the Nonproliferation Treaty itself—is the comprehensive safeguard system of the International Atomic Energy Agency. Even in the case of recipient states not party to the NPT, the IAEA system provides internationally recognized safeguard arrangements to insure that nuclear exports are used for peaceful purposes.

IAEA safeguards entail techniques to account for nuclear materials, reinforced by containment and surveillance measures. Agency experts conduct onsite inspections to verify, through independent means, that safeguard material and facilities are being used for declared purposes. These safeguards can provide a high degree of assurance that any significant diversions will be detected and thus provide a real deterrent.

While a safeguard system cannot provide absolute assurance that all conceivable diversions, however modest, will be detected, it does not have to. What it must do—and what the IAEA accomplishes with confidence—is expose the would-be diverter to a high risk of detection.

We recognize that some question the adequacy of the international controls related to nuclear facilities and materials that have evolved over the years. However in the one instance where a nuclear device was exploded through the use of equipment obtained from outside, safeguards did not exist on the facility or its products. Consequently the question of adequacy of safeguards in this case simply did not arise. In fact, since the inception of safeguards, we know of no nation that has acquired nuclear weapons through any diversion of nuclear material subject to either bilateral or IAEA safeguards.

We believe that the IAEA system—with the active technical, financial, and political support of key suppliers and all nations interested in using nuclear energy for peaceful purposes—will continue to fulfill this requirement. Indeed the IAEA safeguards system continues to be a most vital and singularly important element in the battery of constraints developed over the years in support of our nonproliferation objectives.

Moving Toward Life in a Nuclear Armed Crowd?
(The Wohlstetter Report, Excerpt)

Strategic and Tactical Warning Time, and Bilateral or IAEA Safeguards

A safeguards system -- whether bilateral or multilateral -- can at most ring an alarm. But what events do we want to be warned about? Two possibilities: (1) that a government that has been a long way from being able to manufacture explosives is now within a short distance of that capability. (This is a kind of strategic warning.)

and (2) that a government has "diverted" special nuclear material in violation of an international agreement. (This would be a kind of tactical warning.)

These two events differ. The first is more fundamental. It can occur even if the second does not -- if agreements do not preclude drastically shortening the time to make a nuclear explosive. Strategic indications now abound and their implication is that tactical warning is in some cases nearing zero.

MUF, MAF, and IAEA

The focus of safeguards is on the problem of diversion. Therefore, the inspectorate of IAEA, and possibly the inspectors of an exporting country in a purely bilateral arrangement, fix their gaze on the Material Unaccounted For (MUF) and the Limits of Error in the Material Unaccounted For (LEMUF). The NPT safeguards, for example, essentially consist in verification of accounting records to see whether the Material Unaccounted For is within reasonable limits. Americans contend that the Limits of Error can be reduced to less than half of a percent; other members of the NPT think they cannot be reduced much below one percent. From the standpoint of diversion, it is this very small percentage that is problematic.

However, from the standpoint of the future spread of capabilities to make nuclear explosives with a short time delay, it is trends in the Materials Accounted For (what we might call MAF) that are likely to be decisive. For a variety of reasons, the basic data on the special nuclear materials that are adequately accounted for, owned and controlled by national governments, possibly stocked within their territory and tidily reported at regular intervals in accordance with bilateral or trilateral agreements, are not assembled and reported. They are not what "safeguards" are about (if "safeguards" are taken to mean merely inspection to detect violations). Safeguards have to do with material that conceivably may have been diverted.

Moreover, the IAEA safeguards system specifically prohibits disclosure by any member of the IAEA staff (except to the Director General

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Final report. Prepared for the U.S. Arms
Control andDisarmament Agency. Los Angeles,
Calif. Pan Heuristics. April 22, 1976
pp. 66-72.

and other IAEA members designated by the Director General) of any "confidential information" acquired while implementing agency safeguards.

Paragraph 14 of the basic Safeguard System document of the IAEA reads,

> The Agency shall not publish or communicate to any State, organization or person any information obtained by it in connection with the implementation of safeguards, except that:
>
> (a) Specific information relating to such implementation in a State may be given to the Board and to such Agency staff members as require such knowledge by reason of their official duties in connection with safeguards, but only to the extent necessary for the Agency to fulfill its safeguards responsibilities;
>
> (b) Summarized lists of items being safeguarded by the Agency may be published upon decision of the Board; and
>
> (c) Additional information may be published upon decision of the Board and if all States directly concerned agree.

Observe that even exception (b) which the IAEA Board might make is limited to lists of items safeguarded. There is no exception for reporting the quantities of such items.

The IAEA interprets its mandate as foreclosing any report on the size, physical state, and isotopic and chemical composition of any stocks of special nuclear material present and accounted for, not to say those missing and unaccounted for at specific facilities, except to a very narrowly circumscribed set of staff members of IAEA. In practice, it has meant that up to now* the data on such material accounted for have not been assembled and published even in the form of frequency distributions of the number of countries with various amounts of material of varied type. Still less has there been any analysis of trends in such accounted for stocks. Attention, in short, has been on the half of one percent that might be unaccounted for and not on the 99.5 percent or so that may present the most important problem.

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*i.e., up until the date of our inquiry.

Indeed, the state of public information on these civilian stocks appears to be much worse than that on the supposedly secret and highly sensitive military stocks of missiles and aircraft, etc. which form the regular subject of annual military balances by the International Institute of Strategic Studies and other such organizations. This seems strange. It has its origins in the concern expressed by various competing nuclear exporters about the revelation of commercial and industrial secrets. The text of paragraph 13 of the basic Safeguards System document reads as follows:

> In implementing safeguards, the Agency shall take every precaution to protect commercial and industrial secrets. No member of the Agency's staff shall disclose, except to the Director General and to such other members of the staff as the Director General may authorize to have such information by reason of their official duties in connection with safeguards, any commercial or industrial secret or any other confidential information coming to his knowledge by reason of the implementation of safeguards by the Agency. (Italics added)

In the course of checking material unaccounted for an inspector must necessarily come by and use information as to the material that is accounted for. The rules suggest a presumption that any such information is confidential and not to be disclosed. But it seems quite farfetched to suppose that figures on inventories of separated plutonium and highly enriched uranium would reveal any commercial or industrial secrets of significance to competitors. In fact, scraps of such information can be gained from public sources -- where, for example, the source materials were obtained under license from the U.S. government. It is possible to determine that as of a short while ago Spain had an inventory of between 60 and 70 kilograms of separated plutonium at Windscale, England. This fact is indeed of public interest for anyone concerned with the possibility of future uses of plutonium in explosives, but it reveals no secret of commercial importance about reactor design or the like.

Apparently a sweeping restriction, born of fond hopes for preserving competitive advantage in some ingenious trick of reactor design, has resulted in a kind of overkill, a destruction of information of great public interest and little industrial importance. Whatever the genesis of these constraints on disclosure of information about stocks, the effects are quite perverse. It means that where an exporting country has substituted for a bilateral a trilateral agreement between itself, an importing country and IAEA, it is prevented from receiving information on a possible violation. It can receive only information of confirmed violations and then after a substantial delay--and then, only indirectly. This would tend to reduce the warning time about violation and restrict the possibilities that the exporting country might, by diplomatic means, influence the potential violator to reverse his course. But the most important effects have to do not with warning of violation, but with warnings of the approach towards a nuclear capability -- without violation. For the formation of timely and precisely adapted actions to inhibit the spread, the regular publication and analysis of trends in the stocks of fissionable material accounted for would be extremely important.

The Effective Application of Safeguards as the Assurance of Timely Warning

The proposals in 1945 and 1946 by the pioneers in the discussion of international control of nuclear energy may have been seriously flawed so far as the technical means for assuring control were concerned. They were a good deal clearer and more explicit about the purpose of such controls, however, than the vast bulk of the technical discussions that ensued in the 1950s and the 1960s. Only in recent years has something like the original clarity about the purpose of safeguards been restored. Much of the 1960s discussion of techniques of inspection continued to be troubled by the initial technical flaws, specifically the hope (now generally implicit) for denaturing.

It is hard to understand how so much effort could have been spent in the 1960s on elaborate schemes for "safeguarding" reprocessing plants and plants for manufacturing mixed plutonium and uranium dioxide fuel, both of which would result in stocks of separated plutonium quickly usable in bombs. It may be explained by 1) the implicit persistence of the belief that plutonium separated chemically from power reactor fuel would be safe because it was contaminated by plutonium 240 and 242 (the chemical separation barrier could be removed, so to speak, because the even higher isotopic separation barrier to an explosive remained). Or 2) a focus on the technical means, namely inspection to detect violation, so intense or exclusive as to lose sight of the purpose of the safeguards agreement and the inspection arrangement. The purpose, of course, is to assure timely warning that would deter the manufacture of nuclear explosives or permit appropriate national or international responses to frustrate it.

A concentration on elaborating means to some proximate end (such as "detection") is characteristic of the behavior of large organizations. It is much less characteristic for such organizations to generate thinking concretely about whether the means elaborated are compatible with more remote objectives such as the assurance that no activity will be undertaken that would preclude timely response. It is still rarer to find much soul searching about whether some of the remote objectives are genuinely compatible with each other (like the assurance of early warning, on the one hand, and, on the other, the supposed essentiality of "closing" the fuel cycle by recycling plutonium as a step toward "accelerating and enlarging" the scope of nuclear energy throughout the world.)

If one believed that it was essential to close the fuel cycle, it would provide a powerful impulse to hold fast to the myth of denaturing plutonium. That so many policymakers have continued to cling to this conviction or at least to the hope that diluting plutonium 239 with plutonium 240 or 242 would make plutonium 239 safe is remarkable. Given the doubts that were expressed about such a proposal even before the Acheson-Lilienthal report, it testifies perhaps to our deep wish that power reactor plutonium were safe rather than our firm conviction that it is. Interposing the high barrier of isotopic separation between the use of plutonium for civil and military ends, if it could be arranged, would provide early warning even at today's state-of-the-art of isotopic separation. And early warning, it was understood at the outset, was part of the essence of the problem of safeguards. But the feasibility of such dilution of plutonium was called into question a year before the Acheson-Lilienthal report by a high, scientific authority on the subject--namely, Glenn Seaborg, the discoverer of plutonium--during the writing of the famous Franck report of which he was co-author. The Franck report which was dated June 11, 1945, was directed most immediately against the decision to drop the bomb on Japan, but it also suggested that a "compulsory denaturation of pure fissionable isotopes may be agreed upon by diluting them, after production, with suitable isotopes to make them useless for military purposes, while retaining their usefulness for power engines." Seaborg, commenting on early drafts of the report,* wrote "can't denature 49 by dilution with stable isotopes"** (49 was the wartime code for plutonium whose atomic number is 94). Yet the Franck report was issued without change, presaging our persistent ambivalence on this subject.

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*Now available at the University of Chicago Library in the James Franck papers.

**Dr. Seaborg, in a letter of March 10, 1976, to Arthur Steiner states,

> "My second written comment that 'can't denature 49 by dilution with stable isotopes' certainly refers to my view that isotope Pu-240 was being greatly over-rated as a safeguard against nuclear proliferation. I remember feeling that way the next year when the Lilienthal Board suggested the possibility of denaturing fissionable Pu-239. (Denaturing fissionable U-235 and U-233 is, on the other hand, feasible due to the availability of more stable nonfissionable U-238.) I don't recall why my written comment didn't lead to an alteration in the final version."

One reason the report was unaltered in this respect was very likely that while it ranged widely over the subject of peaceful uses of nuclear energy and international control, it was focused on an immediate decision about an impending military operation; however, it is an early illustration also of how strongly we have hoped to resolve the dilemmas of propagating nuclear electric power without spreading nuclear weapons. We are indebted to Arthur Steiner for this reference and for the reference to Leo Szilard's early views on the subject of denaturing.

The early proponents of the idea of making plutonium safe by contaminating it with stable higher isotopes were ambivalent and troubled by the substantial technical shortcomings of the notion, but they clearly and unequivocally grasped an essential fact of international safeguards which, though reasserted from time to time, has a way of getting lost in the middle reaches of international and national bureaucracies, namely that a safeguard involves more than simply detecting a violation of an agreement; it implies, if it is to deserve the name safeguard, detecting the approach by a government to getting a bomb in time for other governments to do something about it.

Leo Szilard, who discussed the possibility of denaturing even earlier than the Franck report and rather more cautiously (he said, "The possibility would have to be scrutinized carefully"), was quite clear on the critical need for timely detection.

> "A system of controls could be considered successful only if we could count on a period of grace in case the controls were denounced or obstructed by one of the major powers. This means that the system would have to be of such a nature that at least one or two years would elapse between the time the nations begin to convert their installations toward the purpose of manufacturing atomic bombs, and the time such bombs become available in quantity."*

The hopes for a denaturing of plutonium that would compel isotopic separation were disappointed. However, chemical separation has remained as a barrier that takes a substantial, if lesser, amount of time to surmount. Any interpretation of safeguards that removes this last barrier of chemical separation for plutonium and leaves practically no warning time should be recognized as abandoning the essential purpose of safeguards.

If the critical time to make an explosive is allowed to shrink to a few weeks, days, or hours, there will not be enough time for political or military action. For one thing, deciding on appropriate political or military responses would take time, and political responses in themselves might be very time consuming. For another, the warning would not begin with the moment of diversion. The first indication of violation an inspector might have, even if he were on the scene, might be some denial of access, ostensibly perhaps because of a bad radioactive spill. This might be only the beginning of a long sequence of events, restricted at first to the inspected government and the inspector. The IAEA safeguards might assure quick detection for a violation shortly after it takes place, but it cannot assure timely detection well before bomb assembly unless agreed arrangements between importers and exporters keep the critical time between violation and assembly long enough.

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*Unpublished version of "Atomic Bombs and the Post-War Position of the United States in the World," March, 1945, available in the office of the ERDA historian, excerpted in the Bulletin of the Atomic Scientists, December, 1947.

Both the IAEA and the U.S. Government have reiterated the essential point, that the purpose of safeguards (and therefore the objective that would have to be achieved for the application of safeguards to be "effective") is to assure timely detection and the deterrence of diversion through the risk of early detection. That point was made in a report recently transmitted to Congress by the President.* He said, "The international safeguard system deters diversion by the threat of early detection of diversions should they occur at the national level and by the political consequences resulting from reporting of diversion to the international community." General Starbird repeated the point a short time afterwards: "IAEA safeguards provide for the timely detection of diversion of significant quantities of nuclear materials from peaceful nuclear activities and the deterrence thereby of such diversion by threat of early detection."** His assertion faithfully reproduces the objective of safeguards as clearly defined by the IAEA Safeguards Committee: "The timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear explosive devices or for purposes unknown, and deterrence of such diversion by risk of early detection."***

The point of it all may sometimes have been lost. But as the Inspector General of IAEA suggests, "The thirty years history of safeguards is one of continuous development and there is no reason why its techniques and concepts should not undergo many further changes."**** And there is every reason that further evolution should clarify and make more precise the tailoring of safeguards to their essential purpose.

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* Laws and Regulations Governing Nuclear Exports and Domestic and International Nuclear Safeguards, Message from the President of the United States, May 6, 1975, USGPO, Washington, D.C., 1975, p. 35.

** Statement before the Senate Committee on Government Operations, January 29, 1976. The Assistant Administrator for National Security of ERDA.

*** See IAEA INFCIRC/153 (1971) and B. Sanders and R. Rometsch, "Safeguards Against Use of Nuclear Materials for Weapons," September, 1975, Nuclear Engineering International, p. 683.

**** Ibid

IAEA-SM-201/103

SAFEGUARDS — 1975-1985

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Abstract

SAFEGUARDS — 1975-1985.

Implementation of safeguards requires translation of the conceptual objective into practical terms: actual values have to be defined for "significant quantity", "threshold amount", "detection probability", "confidence level", and "timeliness". Limitations are imposed on some of these criteria by the present status regarding nuclear material measurement and the mode of operation of nuclear facilities. A modified approach to verification based on categorization of nuclear material with the aim of limiting the growth of safeguards cost is presented for discussion.

1. NUCLEAR INDUSTRY, DIVERSION HAZARDS AND SAFEGUARDS

Depending on their type, nuclear power plants use for fuel either natural uranium, low enriched uranium, high enriched uranium, plutonium, thorium or mixtures of these. To supply fuel for power reactors a fuel cycle should be set up; for example, in the case of uranium being used as the fuel, uranium ore is dug in the mine, then transferred to the conversion facility where it is purified and converted either to UF_6 for enrichment, or to UO_2 or U-metal. After uranium has been enriched, converted or purified, it is fabricated into fuel elements and loaded into the power reactors. Irradiated fuel is reprocessed at chemical plants, where uranium and plutonium produced in power reactors are separated from fission products, in order to be of further use as fuel for power reactors.

The fuel cycle consists of a series of nuclear facilities handling nuclear material of different chemical forms and different isotopic compositions. Figure 1 shows a typical diagram of a fuel cycle.

Nuclear material which is used in a nuclear fuel cycle may be subject to diversion. The purpose of diversion may vary to a great extent. For example, sufficient quantities of uranium and plutonium with a high content of fissile nuclides (weapon grade) might be used for the fabrication of nuclear explosive devices. Plutonium which is highly toxic may be directly used for creating hazards by dispersion. Natural and low enriched uranium may be used as starting material for producing high enriched uranium; or it may be used for the production of weapon-grade plutonium.

The possible use of diverted material depends on the existence of facilities at the disposal of the diverters. Without enrichment facilities natural or low enriched uranium cannot be converted into uranium of a quality suitable for the fabrication of nuclear explosive devices. Without reprocessing facilities plutonium cannot be extracted from irradiated fuel. Therefore, diversion hazards should be analysed for each particular case on the

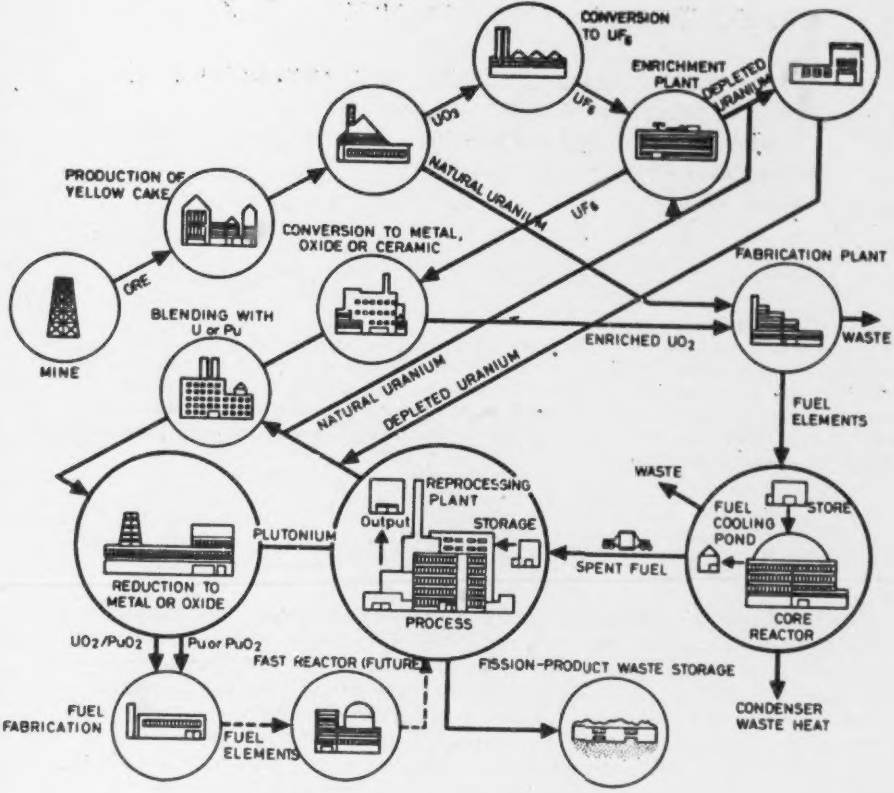
CONVERSION TO UF_6
ENRICHMENT PLANT
DEPLETED URANIUM
UO_3
UF_6
PRODUCTION OF YELLOW CAKE
NATURAL URANIUM
UF_6
CONVERSION TO METAL, OXIDE OR CERAMIC
FABRICATION PLANT
ORE
MINE
BLENDING WITH U or Pu
ENRICHED UO_2
WASTE
NATURAL URANIUM
DEPLETED URANIUM
FUEL ELEMENTS
WASTE
REPROCESSING PLANT
Output
STORAGE
FUEL COOLING POND
STORE
PLUTONIUM
SPENT FUEL
REDUCTION TO METAL OR OXIDE
PROCESS
CORE REACTOR
UO_2/PuO_2
Pu or PuO_2
FAST REACTOR (FUTURE)
FISSION-PRODUCT WASTE STORAGE
FUEL FABRICATION
FUEL ELEMENTS
CONDENSER WASTE HEAT

FIG. 1. The nuclear fuel cycle.

basis of the situation prevailing in the environment under consideration and on the availability of elements which are necessary to achieve the final purpose of diversion.

Because of the possibility of the diversion of nuclear material, systems to keep material under control have been established. The basis of the international control, the safeguards system, is laid down in two Agency documents, INFCIRC/66 Rev. 2 [1] and INFCIRC/153 [2]. The first document forms the basis for safeguards transfer agreements, bilateral agreements and unilateral submissions under which equipment, facility, nuclear material, other material and information are subject to safeguards. The second document forms the basis of all agreements required by Article III of the NPT (Non-Proliferation Treaty), under which nuclear material is subject to safeguards. Based on the requirements of NPT, all peaceful nuclear activities of a State party to NPT should be subject to safeguards. INFCIRC/153 has laid emphasis on nuclear material, considering nuclear facilities only in so far as they contain nuclear material. In principle, safeguards pursuant to NPT do not apply to nuclear facilities which do not contain nuclear material. Contrary to this, INFCIRC/66 Rev. 2 is addressed to nuclear facilities, equipment and nuclear material.

2. PRESENT SAFEGUARDS

2.1. Non-diversion undertaking and safeguards objectives

Since the International Atomic Energy Agency was set up in 1957, the politically acceptable way of implementing safeguards has been through agreements between a State or States and that Organization. Such agreements are invariably built around a basic undertaking of the State. Before the Non-Proliferation Treaty came into force this basic undertaking had always been formulated in the agreement itself, in accordance with the Statute of the International Atomic Energy Agency, as "not to use special fissionable material and other materials, services, equipment, facilities, and information in such a way as to further any military purposes" [3].

A similar undertaking is contained in the Treaty on the Non-Proliferation of Nuclear Weapons, on which agreement was reached in 1968 and which entered into force in 1970. According to this Treaty, States party to it undertake not to divert "nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices". The parties to the Treaty also conclude agreements with the Agency for the application of safeguards. In these agreements the undertaking is not repeated but incorporated by reference.

All types of safeguards agreements concluded with the Agency contain a supplementary undertaking to accept safeguards for the purpose of ensuring that the basic undertaking is continuously honoured. This means that the safeguarding authority has to establish proof that the nuclear materials and equipment are not used for activities which, pursuant to the basic undertaking, must not take place. For many years a subject of discussion has been how it is possible to establish the assurance that something is not done. Out of this discussion has grown the definition of safeguards objectives. Particular care has been taken by the Safeguards Committee 1970 to formulate the objective of safeguards for incorporation in every safeguards agreement concluded in connection with the Non-Proliferation Treaty.

The second part of these agreements, which specifies the procedures to be applied, begins with the definition of the safeguards objective as "timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices, or for purposes unknown, and deterrence of such diversion by the risk of early detection" [4].

The expression "or for purposes unknown" turns the attention from activities which may not take place to the legitimate applications of nuclear energy for peaceful purposes. The expression "timely detection of diversion of significant quantities of nuclear material" focuses attention on the nuclear material and the requirement that it remains within the peaceful nuclear activities. Up to this point the safeguards objective is conceptually developed in the agreements between States and the Agency.

Implementation of safeguards by the Agency involves a further measure of translation of the conceptual objective into practical terms: actual values have to be defined for the "significant quantities" and for other parameters such as detection probability, confidence level and timeliness. The objective becomes technically defined and can be used in the safeguards work. This quantification is based on the verification experience of nuclear material accountancy of the Agency. The values set must be understood as today's performance possibilities; they shall be reviewed along with the progress of technological development. Also, they can only be meaningful within the context and structure of the applied accountancy system and verification scheme.

2.2. Diversion strategies

In spite of stating the objectives of safeguards as "timely detection of diversion ..." safeguards measures which are based on material accountancy cannot detect diversion as such. The plant operator may remove nuclear material from any process stage at the facility except where strict containment-surveillance measures are applied. However, if safeguards procedures lead to detection of anomalies which require further investigation, then the objectives of these procedures have been fulfilled.

The operator can use several ways to divert the required amount of nuclear material: removal of complete items; removal of part of the material from some items; removal of a small amount of material from all items.

The means of concealment of diversion might be arbitrarily grouped into: (a) Falsification of records and reports, i.e. not recording part of the received material, declaring non-existing shipments to some other facilities, stating that material was discarded or accidentally lost, stating that all material is still physically present at the facility; and, (b) allowing the diverted quantity to appear as a part of MUF without falsifying any records or reports. However, the amount of material, the diversion of which can be concealed in this way, is limited and depends on the accuracy of the accountancy of the particular facility.

2.3. Safeguards measures

The safeguards agreements between the Agency and the States party to NPT imply that the objective of safeguards, which is in principle addressed to all peaceful nuclear activities within the jurisdiction of a State, shall be technically defined for areas in or outside facilities, called material balance areas (MBA), such that the quantity of nuclear material transferred into or out of them and the physical inventory of nuclear material can be determined. "The technical conclusion of the Agency's verification activities shall be a statement in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated" [5]. The technical objective of the Agency's verification activities shall, therefore, be to detect with a defined probability a defined quantity of nuclear material if missing within a period of time for each material balance area. For this purpose NPT safeguards agreements provide for "the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures".

The operators of nuclear facilities shall, for the purpose of economic and safe nuclear material management, account for the nuclear material. Accountancy by the operator consists of acquiring knowledge of initial inventories of nuclear materials, subsequent inventory changes and, with a certain periodicity, the inventory present. This knowledge is based on measurements which have an inherent uncertainty which is transferred to the accounts. Adding and subtracting changes from the initial inventory defines the amount of nuclear material which should be in a given material balance area, called the "book inventory". With a certain periodicity the operator shall close the material balance by determining the amount of material present, called the "physical inventory". The difference between book and physical inventory is called "material unaccounted for", and has also an uncertainty. The State shall, in order to enable the Agency to verify its accountancy, provide the Agency with design information and reports and make available accounting and operational records for verification; moreover, the Agency has the right to carry out verification of nuclear material.

2.4. Requirements

To enable the Agency to fulfil its obligations, a set of requirements has been incorporated in each safeguards agreement. The manner in which general procedures as laid down in agreements are really applied at different facilities is specified in the Subsidiary Arrangements and Facility Attachments.

The basis for the verification of amounts and locations of nuclear material is determined in the course of examination of design information prior to the initiation of safeguards at a given facility. This is the stage where verification procedures are specified for the facility based on the design information provided by the State or obtained when inspectors verify design information at the facility. At this time safeguards measures are selected and an initial balance between the activity of the Agency and States' Systems of Accounting for and Control of Nuclear Material (SSAC), which should be established and maintained [6, 7], is determined in respect of each facility or material balance area. Since these important decisions are made a priori, the instrument provides for adjustment of the safeguards procedures, when actual operating experience becomes available, by an extension or change of the Subsidiary Arrangements without amendment of the Agreement.

The operator of each nuclear facility should maintain records with respect to the accounting status of all transfers between material balance areas as well as inventories of such material within material balance areas. The records, maintained and described in the Subsidiary Arrangements, form a basis for the Agency's system of accounting for and verification of all amounts and locations of nuclear material subject to safeguards.

The reports provided by the State are used to give the Agency a timely picture of the flow and inventory patterns of fuel cycles and to provide thereby a basis for effective deployment of the safeguards effort. The internal consistency of reported information and the comparison and correlation of flow between facilities provide means for knowledge of amount and location of nuclear material independent of the information collected during inspection.

Inspections are the main element of the Agency's systems for accomplishing its obligations. The primary purpose of inspections is to verify information provided by the State to the Agency in the form of design information and reports and to collect and verify information available in records.

2.5. Verification

2.5.1. General

The verification of material accountancy by the Agency's inspectorate is the safeguards measure of fundamental importance. The numerous components of a material balance, the receipts into a material balance area, the shipments out of it, the beginning and the ending inventories are cross-checked by independent measurement. To avoid that verification results in duplication of the operator's activity by the inspectorate, statistical procedures are used to plan the verification activities and to evaluate the information collected. "Random sampling plans" are the basis for identifying the "sample population" to be verified through independent measurements.

2.5.2. Technical criteria

The Agency sample plans are based on the following criteria: (a) The probability of detecting a loss of material is chosen to be 0.95 when in fact the true loss is a defined significant quantity; (b) the probability of falsely concluding that a defined significant quantity is lost when no loss actually occurred is chosen to be 0.05; (c) the significant quantities which are based on the measurement uncertainty that can be reasonably achieved with the measurement technology of today.

Therefore, the accuracy regarding nuclear material measurement provides the first basis for defining a significant quantity of nuclear material to be detected if missing. The Agency has compiled performance data on nuclear material determination both from facility operators and from laboratories in Member States where advanced methods are being developed. From these data accuracies have been derived to apply to any facility covering the same type of production (Table I). Today, quite a number of facilities actually do somewhat better than these figures would indicate. However, roundings to the highest defendable value are made to avoid discussions over individual performances.

Technical Working Groups [8, 9] recommended, as "threshold amount" against which to compare the results of the Agency's verification activity, the use of 1 - 8 kg Pu and 1 - 25 kg contained ^{235}U per year and per MBA. The upper limit of these ranges represents fast critical mass of weapon-grade materials. The expected uncertainty would exceed these values for industrial facilities with high throughput. The operator himself cannot state that the value of the material unaccounted for in its material balance means a real loss or gain of material unless it is, at least, twice the value of the uncertainty in the material balance. The verificator can only detect the gain or loss of an amount of material larger than these, because of the effect of the combination of the operator's and the verificator's measurement uncertainties.

TABLE I. ACCURACY (STANDARD DEVIATION) OF A MATERIAL BALANCE EXPECTED BY THE AGENCY

Type of facility	Operator's accuracy[a] (% of throughput or inventory)
Uranium isotope enrichment	± 0.2
Uranium fuel fabrication	± 0.3
Plutonium fuel fabrication	± 0.5
Uranium in power reactors	± 0.2
Reprocessing, uranium line	± 0.8
Reprocessing, plutonium line	± 1.0

[a] These accuracies are expressed as one standard deviation and represent the total random and systematic error components of a material balance.

A possible approach could be to set the values of the significant quantities of nuclear material to be detected by the verificator, if missing, at equal to twice the combined operator's and verificator's uncertainties. The approach does, however, require a substantial effort and still does not permit the detection of a loss of material in quantities equal to even the upper value of the threshold amount in the case of industrial facilities with a high throughput. Other safeguards measures such as containment and surveillance would in any case have to be employed. Therefore, the question arises whether, on setting the values of the significant quantity, one should take into consideration other factors.

INFCIRC/153 implicitly recognizes that fast critical mass cannot be reached with Pu containing less than 20% fissile nuclides [10]. It is even doubtful that the States would use plutonium or uranium material with a content of fissile nuclides below 80% for manufacturing nuclear explosive devices. However, uranium may be enriched or used for the production of plutonium; enrichment of plutonium is not feasible with the present industrial technology. Thus, the importance of uranium depends on the contents of fissile nuclides and enrichment capability of the country; the importance of plutonium is defined by content of fissile nuclides. The importance of both uranium and plutonium decreases if they are in the form of irradiated fuels and the country has no reprocessing capability. Tables II and III present a categorization of nuclear material based on the content of fissile nuclides, the contents of radioactive β- and γ-emitters, and the characteristics of the States' nuclear fuel cycle, which may be taken into consideration on setting the values of the significant quantities.

"Timely detection" as used in INFCIRC/153 [5] was originally based on the concept of "critical time", the approximate time needed to convert a particular form of nuclear material to the form needed to manufacture a nuclear explosive device. In some cases this concept would require an impossible frequency for taking physical inventory: every 10 days for reprocessing and mixed-oxide fuel fabrication facilities. A possible approach is to base the criteria for "timely detection" on the limits of technical

TABLE II. CATEGORIZATION OF URANIUM ACCORDING TO ITS IMPORTANCE FOR SAFEGUARDS

Characteristics of the State's nuclear fuel cycle	Content of fissile nuclides (%)					
	> 50		50 - 20		< 20	
	Content of radioactive β-γ emitters (Ci/kg)		Content of radioactive β-γ emitters (Ci/kg)		Content of radioactive β-γ emitters (Ci/kg)	
	$< 10^5$	$\geq 10^5$	$< 10^5$	$\geq 10^5$	$< 10^5$	$\geq 10^5$
No reactor No reprocessing No enrichment	1	3	2	3	3	3
Reactor No reprocessing No enrichment	1	3	2	3	3	3
Reactor Reprocessing No enrichment	1	1	2	2	3	3
Reactor Reprocessing Enrichment	1	1	1	1	1	1
Enrichment No reprocessing	1	3	1	3	1	3

TABLE III. CATEGORIZATION OF PLUTONIUM ACCORDING TO ITS IMPORTANCE FOR SAFEGUARDS

Characteristics of the State's nuclear fuel cycle	Content of fissile nuclides (%)				
	> 80		80 - 20		< 20
	Content of radioactive β-γ emitters (Ci/kg)		Content of radioactive β-γ emitters (Ci/kg)		
	$< 10^5$	$\geq 10^5$	$< 10^5$	$\geq 10^5$	
No reprocessing	1	2	2	3	Exempted from Safeguards
Reprocessing	1	1	2	2	

feasibility for the physical inventory taking and impose them as requirements on operators. Another alternative, which has been chosen by the Agency, is to base these criteria on "operator's practice expected by the Agency". The number of inventories to be verified by the Agency might, at the limit, be equal to those taken by the operator.

2.5.3. Influence of the effectiveness of the SSAC on the Agency technical criteria

There is no agreed procedure to quantify the effectiveness of the SSAC. The Agency can, however, judge qualitatively how activities of the SSAC facilitate the discharge of its own task and on this basis establish the technical criteria of its own verification activity.

3. THE FUTURE OF SAFEGUARDS

3.1. Nuclear power growth

The magnitude of the safeguards work would seem to depend primarily on the amount of nuclear material in the fuel cycle required to produce nuclear electrical power. The distribution of the nuclear material over the different facilities of the fuel cycle, such as enrichment facilities, fuel fabrication and reprocessing plants, and the flow-rate through or the hold-up in all these facilities, also have a great influence on the safeguards work.

Power production in the Member States from the announced nuclear power plants in operation, under construction and planned, leads to the growth curve presented in Fig. 2. A high degree of uncertainty must be taken into account for the second part of the period covered by this forecast, the

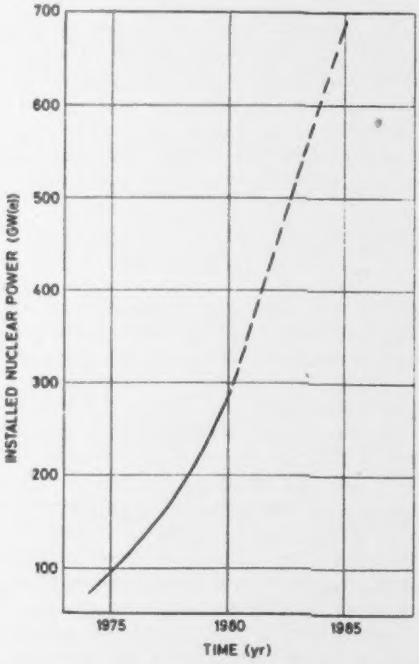

FIG. 2. Forecast of the world's nuclear electrical power in the period 1975 - 85.

TABLE IV. NUMBER OF FACILITIES IN THE NUCLEAR FUEL CYCLES

Type of facility	1975	1977	1980	1985
Power reactors	200	280	420	800
Uranium fuel fabrication facilities	24	28	36	55
Uranium and plutonium mixed-oxide fuel fabrication facilities	21	23	26	30
Irradiated fuel processing facilities	6	8	12	17
Enrichment facilities	8	9	10	13

production growth in the first part of the 'eighties coming from power plants which are today in the planning stage and for which a firm construction decision is still pending.

A summary of the information compiled by the Agency on the number of nuclear facilities to come into operation during the decade 1975 to 1985 is shown in Table IV.

The type of reactor to be used has been announced for practically all the power stations mentioned in Table IV. It is therefore possible to calculate the nuclear material inventory used for their operation, as well as the plutonium production, based on the average values experienced today. Figure 3 presents the inventory of natural and low enriched uranium in power reactors. Figure 4 presents the inventory of plutonium in thermal and fast reactors, as well as cumulative amounts of plutonium in the spent fuel of thermal reactors.

3.2. Safeguards cost

The analysis of the structure of the cost of safeguards indicates that its main component is due to the inspection manpower required to achieve the technical objective. The optimization of the other components can only lead to a small reduction of the cost. The number of inspectors required for a determined inspection effort depends on the ratio of field work-time to total work-time of inspectors. Once this ratio reaches its maximum achievable value, any substantial reduction of cost can only be obtained by reduction of the safeguards effort. The inspection effort in the year 1980 would consist of nearly 100 inspection man-years, distributed as follows: 18% for nuclear power reactors, 26% for conversion fuel fabrication facilities, 33% for fuel reprocessing facilities, 14% for mixed-oxide fuel fabrication facilities, the rest being due to inspection in research and development facilities.

The first alternative approach to the reduction of the inspection effort is to increase substantially the values of the significant quantities of nuclear material to be detected by the Agency, if missing, for nuclear material of categories 2 and 3.

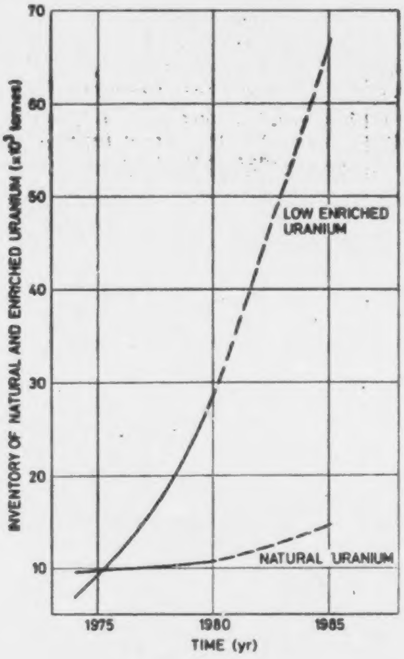

FIG. 3. Inventory of natural and enriched uranium in power reactors.

The second alternative approach to a reduction of the inspection effort is to carry out Agency safeguards verification activities on category 2 and 3 material with the aim of providing either an assurance that the operator has an adequate capability to account for and to control nuclear material or an assurance that the operator's performance in accounting for and control of nuclear material is adequate, defined in a past panel meeting [11] as Level I verification, instead of an assurance through independent verification that facility accounting for and control of nuclear material has been effective, defined as Level II.

The use of the categories of nuclear material to define the safeguards verification activity implies that the range of fissile nuclides content in the nuclear material is correctly assessed by the Agency. Thus, the Agency verification activity should provide assurance on the range of fissile nuclides content in the nuclear material.

The above-mentioned second alternative approach implies that the Agency can exercise its right to carry out Level II verification activity on nuclear material of categories 2 and 3, when appropriate. However, the Agency shall judge whether the effectiveness of the State system of accounting for and control of nuclear material enables it to suspend the exercise of its right of Level II verification of nuclear material of categories 2 and 3.

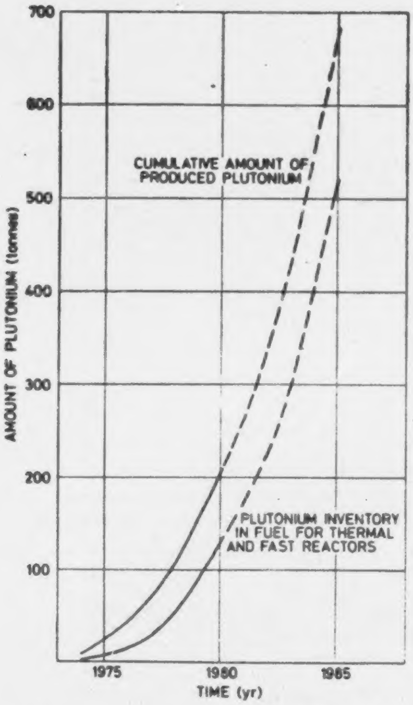

FIG. 4. Cumulative amount of produced plutonium and inventory of plutonium in fuel for thermal and fast reactors.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, The Agency's Safeguards System (1965, as provisionally extended in 1966 and 1968), INFCIRC/66 Rev. 2.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153 (1971).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Agency Statutes, Statute as amended up to 1 June 1973, Article III, Functions, Item 5.

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, see Ref. [2]. Objective of Safeguards, Part II, Article 28.

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Ibid., Article 30.

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Ibid., Part I. National System of Accounting for and Control of Nuclear Material, Article 7.

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, see Ref. [4]. Articles 31 and 32.

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, Report on the Working Group on Quantitative Data and Results of Systems Analysis and Integral Tests, Vienna, 4-8 Oct. 1971, PI-455 (unpublished).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Report on the Working Group on Accuracy of Nuclear Material Accountancy and Technical Effectiveness of Safeguards, Vienna, 28 Aug. - 1 Sep. 1972, PI-488 (unpublished).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, see Ref. [2], Part 1, Exemptions from Safeguards, Article 36(c).

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, Report on the Panel on Systems of Accounting for and Control of Nuclear Material, Tokyo (Japan), 5-9 Nov. 1973, PI-581 (unpublished).

94th Congress
2d Session

COMMITTEE PRINT NO. 17

SAFEGUARDS IN THE DOMESTIC NUCLEAR INDUSTRY

A REPORT PREPARED BY

THE SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS

OF THE

U.S. HOUSE OF REPRESENTATIVES

NINETY-FOURTH CONGRESS

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LETTERS OF TRANSMITTAL

Committee on Interior and Insular Affairs,
U.S. House of Representatives,
Washington, D.C., September 3, 1976.

Members of the Committee on
Interior and Insular Affairs,
U.S. House of Representatives,
Washington, D.C.

Dear Colleagues: A major concern of the Committee's Subcommittee on Energy and the Environment is the problem of security in the domestic nuclear industry. This is the problem of protecting against theft of materials from which nuclear explosives might be constructed. It is also the problem of safeguarding against sabotage that could result in radioactive materials being released into the environment.

Since this is a matter of concern to all of us, I am forwarding to you the following report based on the subcommittee's efforts in the area of domestic safeguards.

Sincerely yours,

James A. Haley, *Chairman.*

Committee on Interior and Insular Affairs,
U.S. House of Representatives,
Washington, D.C., September 1, 1976.

Hon. James A. Haley,
Chairman, Committee on Interior and Insular Affairs, U.S. House of Representatives, Washington, D.C.

Dear Mr. Chairman: Transmitted herewith is a report concerning security in the domestic nuclear industry. The report is based on hearings before the subcommittee and on materials the subcommittee has received subsequent to the hearings. The hearings, held February 26 and 27, were chaired at my request by my colleague, Paul Tsongas.

Information provided us indicates a major discrepancy between the security threats the Nuclear Regulatory Commission believes to be plausible and the security measures required to protect against such threats. The Commission has failed to make hard choices about security in the nuclear industry; it should decide either that the threat to security is overblown and that existing protection systems are adequate, or it should decide the threat is, or could well be, of major proportions and that much more stringent measures are needed.

This failure to choose confuses further the debate over nuclear policy and this confusion and indecision adds to the Congress problems in weighing the arguments presented us by the various factions.

I believe the following report and hearing record on which it is based will be of considerable assistance to the Congress in understanding the problem of security in the nuclear industry.

Sincerely,

Morris K. Udall,
*Chairman, Subcommittee on Energy
and the Environment.*

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SAFEGUARDS* IN THE DOMESTIC NUCLEAR INDUSTRY

INTRODUCTION

On February 26 and 27, 1976, the House Interior and Insular Affairs Committee's Subcommittee on Energy and the Environment, pursuant to its nuclear oversight responsibilities, held hearings concerning security in the domestic nuclear industry. The hearings were held in consequence of events occurring early in 1976 which called to question the ability of the nuclear industry's security systems to protect against theft and sabotage. Among the events were:

Release of a memorandum written by the Director of the Nuclear Regulatory Commission (NRC) Division of Safeguards which contained a statement of concern that currently licensed facilities might not have safeguards adequate against the threat being considered as the basis for planning in NRC safeguards studies.

Appearance of failures in the safeguards system at an Erwin, Tenn. facility which handled substantial quantities of highly enriched uranium.

A petition by the Natural Resources Defense Council to the Nuclear Regulatory Commission asserting insufficient security and requesting either that security be upgraded or that certain facilities be required to shut down.

At the outset, the acting chairman, Congressman Paul Tsongas, stressed the subcommittee's concern that there be public understanding of the safeguards problem:

> If we are to have nuclear power, it is essential that not only should hazards be small, but that the public be aware of what those hazards are. Mere assurances that everything is all right will not suffice.

During the course of the hearing, the subcommittee sought information with regard to the nature of threats against which protection was required, with regard to steps necessary to provide protection against these threats, and with regard to whether the requisite measures were in effect. The purpose was to develop a base for a subcommittee judgment as to the adequacy of security against current and projected threats.

This report contains analysis and conclusions based primarily on the February 26 and 27 hearing record and subsequent communications between the subcommittee and the Nuclear Regulatory Commission. Section I addresses the nature of the threat to security. Section II concerns nuclear reactors' intrinsic vulnerability (or lack thereof) to sabotage. Section III discusses nuclear material accounting and control systems.

Section IV discusses safeguards system adequacy. Conclusions are presented in section V. Appendix A addresses the question of Federal operation of the system which transports materials that could be fabricated into nuclear explosives. Appendix B is an NRC letter responding to a subcommittee request for information with regard to the adequacy of security measures.

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* For purposes of this report, "Safeguards" refers to security systems designed to protect against malevolent acts which could lead to release of radioactive substances into the environment.

Unless otherwise noted "hearing record" refers to "Oversight Hearings on Nuclear Energy—Safeguards in the Domestic Nuclear Industry"; U.S. Congress, House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment, 94th Congress, 2d session, February 26 and 27, 1976, serial No. 94-16, part VI.

I. The Threat

The use of nuclear energy for electric power generation leads to production of substantial quantities of plutonium and radioactive residuals of the fission process. Plutonium and highly enriched uranium in amounts of 20 pounds or more might be fabricated into nuclear explosives; plutonium in very small quantities is exceedingly toxic. The radioactive byproducts of the fission process, if released from their containers, have the potential for causing a widespread hazard to human health. Because of the dangerous nature of these materials, great care must be taken to insure that they do not come under control of persons with malevolent intent. Plutonium and highly enriched uranium must be protected against theft; nuclear reactors, spent fuel repositories, and fuel reprocessing plants must be guarded against those who would threaten or cause actions leading to release of radioactive materials contained therein.

Testimony before the subcommittee showed that those responsible for nuclear security must consider a diversity of threats: theft of plutonium by criminals who might sell the material to a nation wishing to possess nuclear weapons, but not having a means of producing nuclear explosive materials; theft by terrorists intent on building their own nuclear bomb or plutonium dispersal device; threat or conduct of sabotage by terrorists seeking to create social disorder; and sabotage by deranged individuals. Witnesses disagreed widely with regard to how likely it was that such threats would materialize; they disagreed about willingness of conspirators to incur risks in carrying out illicit action; about whether threatening groups would have the requisite skill and resources; and about motivations to cause widespread death and destruction. A sampling of the expert views follows.

Dr. Bowyer Bell, of Columbia University and an expert on revolutionary violence said:

> There is about the entire subject of nuclear terrorism a dreadful lack of precision. There can be no absolute assurances. There may be those with the will, capacity, and the desire to steal plutonium or detonate a bomb in a powerplant to cause a meltdown. The chances are slim that there are many so inclined in the United States and slimmer that a foreign organization will be so attracted. But in nuclear matters a qualitative estimate that the threat is remote is cold comfort. Somewhat more reassuring is the obstacle facing any such terrorist venture; yet the terrorist may assume a vulnerability where little exists, may launch a failed operation so spectacular that a frightened public will perceive a present danger.[1]

Brian Jenkins, Rand Corp. director of research on political conspiracy and violence, guerrilla warfare and international terrorism presented testimony stressing the importance of keeping nuclear terrorism in perspective:

> We should not exaggerate the threat. The potential consequences of serious sabotage leading to a radioactive release, the fabrication of an illicit nuclear explosive device, or plutonium contamination are serious. But I have tried to point out why some of the more horrendous scenarios in which hundreds or thousands of lives might be imperiled appear less likely.

---

[1] Hearing record, p. 60.

> There are disincentives, even among those we call terrorists, to carry out these extreme acts. And they are not that easy to accomplish. Planting a bomb at a tourist attraction or seizing hostages in a consulate is a far easier task than destroying a nuclear reactor or making—not designing, but making—a nuclear bomb. We should not overestimate the capabilities of terrorists.
>
> They tend to operate at a low level of efficiency.[2]

Dr. Douglas DeNike, a clinical psychologist and technical consultant with Californians for Nuclear Safeguards, presented a more pessimistic prognosis:

> . . . The general problem of crime and violence is enormous, and it is still increasing . . ..
>
> It has been said, "Terrorists want a lot of people watching, not a lot of people dead . . . mass casualties simply may not serve the terrorists' goals." This formulation appears to be a frail reed upon which to lean, since any newsperson will readily grant that the more people dead in a given atrocity, the more people will be watching the account on the evening news . . ..
>
> Even apparently overwhelming odds in favor of nuclear facility security forces might not deter those possessed of this kind of (extremist) mentality. While it is tempting to divide domestic insurgents into hot-blooded and cold-blooded categories, such a distinction would have limited application. The very same groups can show signs of crafty calculative ability at some times, and intemperate quasi-delusional behavior at others.[3]

A hedged assessment of the threat was presented by Mr. Kenneth Chapman, Director of the NRC's Office of Nuclear Material Safety and Safeguards:

> There is no information available to us which indicates that any group is planning an act of theft or sabotage against the licensed nuclear industry at this time.
>
> Nevertheless, there is a continuing potential for insiders to execute malevolent acts or to provide assistance to outsiders in the execution of acts which could result in adverse impacts on the Nation.
>
> Furthermore, there are organizations with malevolent intent which could develop the capability to carry out operations against the licensed nuclear power industry.
>
> Our studies have concluded that there is evidence to support the possibility that present threat groups may be highly motivated and disciplined; well equipped and financed; well trained; well prepared to execute the tasks they have selected.
>
> * * * * * * *
>
> The exact threat then, to summarize, cannot be predicted with confidence, since it is an inherently uncertain problem and history is an unsure guide to the future. My assessment, however, based on currently available evidence and expert opinion is that an attack on nuclear facilities would likely stem from a relatively small number of persons, possibly aided by an insider.[4]

Following the hearing, the NRC was requested to be more specific with regard to the threat. The subcommittee asked:[5]

> What kinds of resources, expertise, and capabilities are assumed to be possessed by threatening persons or groups?

The NRC response submitted for the record was as follows:

> NRC feels that it is possible that adversaries may possess any of the following:
>
> *Equipment.*—Semiautomatic pistols and rifles; automatic pistols and rifles; submachine guns; shotguns; hand grenades; machine guns (up to 50 caliber); dynamite; plastic explosives; shaped charges; citizen band radios; two-way radios; general and special purpose vehicles; aircraft (fixed-wing and helicopter); tear gas, MACE, etc.; light mortars;* hand held air-defense weapons;* and light antitank weapons.*

---

[2] Ibid., p. 41-42.
[3] Ibid., p. 21-25.
[4] Ibid., p. 150.
[5] Ibid., p. 183-185.

*NOTE: While not as readily available as the other items, these are known to be available to terrorist groups.

Individual and team skills.—Nuclear materials identification and handling; radiation monitoring and safety; communications; intelligence and security (reconnaissance, surveillance and alarm systems, etc.); tactical operations (combat experience); pioneer (demolition, structure and barrier breeching); transportation; and managerial.

Terrorist groups (especially foreign) and organized crime are well known to have adequate resources to mount highly organized, well-planned, and extremely violent and disruptive acts. Therefore, NRC feels that it is prudent to assume that potential adversaries might possess any of the above described resources, expertise, and capabilities.

The NRC also indicated in a July 20, 1976 letter to the subcommittee that for purposes of its review of adequacy of security, it assumes a group consisting "at a minimum, of three well-armed, well-trained persons, who might possess inside knowledge or assistance." [6]

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[6] See appendix B.

II. REACTOR SABOTAGE

One session of the hearing series focused on the question of the vulnerability of reactors to sabotage of a kind that would lead to the release of substantial quantities of radioactive materials into the atmosphere. Recognizing that vulnerability to sabotage is not entirely independent of the resources and motivations of those who might undertake such sabotage, the subcommittee sought information to indicate what kinds of difficulties might confront a saboteur.

Several of the witnesses held the view that the design and construction characteristics that made reactors safe with respect to accidents also made them safe against sabotage. However, an inference from the totality of the testimony is that while security from sabotage can be achieved, such invulnerability may not exist at all operating reactors.

On the one hand, to indicate invulnerability in principle, there is testimony of Dr. David McCloskey, Director of NRC-sponsored reactor sabotage studies at the Sandia Corp.:

> These acts of sabotage in a nuclear powerplant could be highly destructive and expensive to the operating utility, but we feel that it is extremely unlikely that they would cause a radioactive release.
>
> Sabotage which might endanger the public could only be carried out by knowledgeable, capable personnel having a high degree of technical competence. Such an attack would require thorough planning and coordination in order to mount an effort to bypass the plant security system and to disable or destroy elements of several plant systems in the multiple plant defenses against a radioactive release.[1]

In prepared statements other witnesses made a similar point. Dr. Norman Rasmussen, professor of nuclear engineering at M.I.T. and Director of the NRC's Reactor Safety Study stated:

> The conclusion that it would be difficult to cause serious public damage was not based upon the degree of difficulty in overcoming the security system of the plant, but rather the difficulty of damaging all the equipment necessary to cause a large release of radioactivity.
>
> As you know, nuclear plants have numerous systems whose function is to minimize such a risk. It would take a person very knowledgeable in the details of the plant as well as sabotage techniques to accomplish this.
>
> If one looks at the senseless, terrorist acts that have been carried out in recent years, one finds that rarely do they exhibit the degree of sophistication required for successful nuclear plant sabotage.[2]

In another prepared statement, Mr. Bernard Cherry of General Public Utilities Corp. of New Jersey said:

> It is extremely unlikely that an act of sabotage can result in harm to the general public.
>
> In view of the difficulties in initiating potentially serious accident sequences, the favorable conclusions regarding nuclear powerplant safety are not diminished by the threat of acts of sabotage . . . .[3]

---

[1] Hearing record, p. 85.
[2] Ibid., p. 98.
[3] Ibid., p. 102.

On the other hand, there was also testimony casting doubt as to whether the potential invulnerability had been achieved in practice. Such testimony was received from Robert Pollard, a former NRC employee who resigned his position because of his concerns about nuclear safety. In his former position, Mr. Pollard had engaged in preparation of design standards and in review of reactor safety system design. He stated:

> In our review of license applications on the NRC staff, we do not consider at all the possibility for sabotage in deciding whether or not a particular design is acceptable.[4]

This suggests that actual designs may not take into account the possibility of sabotage. For example, Mr. Pollard suggested that in some situations vital and redundant safety systems could be made ineffective by relatively simple acts of sabotage because of the manner in which control cables were configured. Mr. Pollard thus implies that if a person bent on sabotage were to gain access to an area through which vital cables passed there might be opportunity to prevent operation of redundant systems, possibly leading to a loss of ability to cool the reactor and hence to a core meltdown.

Prevention of this kind of act would thus appear to depend upon first, saboteurs not knowing the physical location of such vulnerabilities, and second the ability of the physical security system to prevent access to areas in which the vulnerable systems are situated. If this be the case, there is reason to doubt Professor Rasmussen's conclusion that the public was protected against harm from saboteurs not because of the difficulty in overcoming the plant security system, but because of the difficulty of damaging equipment to the extent that a large release of radioactivity would be caused.

In fact, Rasmussen himself, said in response to Pollard's comment that the NRC regulatory staff paid insufficient attention to cable routing:

> Yes, and I think that this is a case, where doggone it, if the staff doesn't start looking at it after this eye-opener,[5] they darn well ought to.[6]

Finally, while the thrust of the McCloskey testimony was that reactor sabotage was a problem which could be satisfactorily dealt with in principle, McCloskey was vague as to whether this invulnerability existed in practice. For example, he speaks of the Sandia sabotage study recommendations having all been taken into account in proposed NRC regulations (regulations which are not yet in effect); but McCloskey does not say how many of the recommendations, in addition to being taken into account, actually were translated into the proposed regulations.[7] This leaves open the question as to how close the actual security systems come to the level implicit in McCloskey's conclusory statement.

---

[4] Ibid., p. 103.

[5] This is in reference to the fire at TVA's Brown's Ferry nuclear generating station which occurred on March 22, 1975. The fire was initiated by a workman using a candle to test for air leaks at a point where electric control cables passed through a wall. The fire damaged several hundred control cables, causing failure of certain safety systems. Brown's Ferry units 1 and 2 have not yet reentered service.

[6] Ibid., p. 113.

[7] "The proposed NRC regulations published in November 1974 for comment took account of our recommendations and would implement certain of these." Ibid., p. 86.

III. MATERIAL ACCOUNTING AND CONTROL

Proper design of facilities and careful accounting of materials can prevent surreptitious theft of nuclear materials by persons familiar with the workings of a facility. However, the usefulness of material accounting procedures is limited by the inherent accuracy of measurement techniques.

The revelation of large uncertainties with regard to inventories of highly enriched uranium at a plant in Erwin, Tenn., raised the question of the degree of accuracy that might be expected from material accounting and control systems. Further doubts concerning the accuracy of these systems were raised by a recent report prepared by the Government Accounting Office and submitted to the Subcommittee on Energy and the Environment of the House Small Business Committee.

In view of apparent limitations on the accuracy of material accounting systems, the subcommittee requested the NRC to state its view of the role of such systems in the overall safeguards process. The NRC esponse follows:

> Material control—comprised of access controls, containment, and material accounting—reinforce the protection provided by physical security measures and provides a quantitative basis for material accountability. Material control measures are especially effective against internal diversion where the participants have authorized passage through barriers and access to material in the normal course of business.
>
> The material accounting system can deter and detect, but not prevent the theft or diversion of material. The accounting system should be capable of continuously tracking the location and the movement of all discrete items and containers of SNM on inventory and of monitoring the in-process inventory for indicators of diversion. Through shipper-receiver comparisons, data monitoring programs, and periodic physical inventory checks, the accounting system provides positive assurance that SNM is indeed present. Should a significant loss of material occur, the system should be capable of identifying the general location and the quantity of material involved. The accounting system provides backup detection capability for theft and diversion which circumvent detection capabilities provided by physical security and other material control measures. Internal audits are directed to assuring that records have not been falsified.
>
> Reliance cannot be placed solely on material accounting to detect theft and diversion because the effectiveness of the system is limited by timeliness and measurement uncertainties. Inventory discrepancies caused by measurement uncertainties will continue to occur in nuclear plants, especially, where chemical processing and scrap recovery are required. Accordingly, NRC is working on in-depth protection systems to prevent, deter, detect, and defeat any attempt to illicitly remove nuclear material from facilities.[1]

The inference from this is that prevention of diversion of small but significant quantities of plutonium depends not upon material accounting systems but upon tight control of access to and egress from plant areas from which plutonium or highly enriched uranium might be diverted.

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[1] Ibid., p. 191-192.

IV. ADEQUACY OF SECURITY SYSTEMS

The subcommittee heard conflicting views with regard to the ability of existing and future security systems to protect against nuclear malevolence. Testimony at the hearings by representatives of the NRC, ERDA, and industry concluded, in effect, that safeguards were now adequate and could be improved should the threat level increase over that which was currently perceived. For example, in summarizing his assessment of the ability of safeguards systems to deter and defeat attempts at theft and sabotage, Mr. Chapman in his capacity as Director of NRC's Office of Nuclear Materials Safety and Safeguards stated:

> Present nuclear industry security measures are expected to deter most attacks and to prevent the success of such attacks as are attempted. It should be noted that the nuclear industry has customarily taken the approach of going beyond the normal precautions taken elsewhere in society in facing uncertain contingencies. The same conservative approach is being taken in nuclear safeguards, to the extent that we believe the total safeguards system for the industry, including onsite and offsite security forces, can protect against theft or sabotage attempts by groups larger than those thought to constitute the most likely threat.
>
> * * * * * * * *
>
> May I say in closing, Mr. Chairman, that my operating philosophy is that one should never be quite satisfied with the status quo in safeguards. Safeguards will always be under review and will always be evolving. We will continue to make changes in our programs as conditions warrant and as new technologies develop. We are confident we can now design cost-effective systems for the future by using practical, available solutions; by keeping closely attuned to ERDA's R. & D. programs; and by striving to attain inherently secure plant designs utilizing the proper balance of guards, security devices and material control and accounting systems.[1]

Testimony presented by representatives of the Natural Resources Defense Council (NRDC) maintained that security was inadequate to protect against the threats the NRC appeared to consider plausible. Prior to the hearings the NRDC had petitioned the NRC to require either an upgrading of security at certain facilities or that these facilities not be allowed to possess significant quantities of plutonium or highly enriched uranium.

To substantiate their assertion concerning the inadequacy of security, the NRDC witnesses cited the previously noted memorandum of the Director of the NRC Division of Safeguards which contained the statement:

> I am concerned that some or even many of our currently licensed facilities may not have safeguards which are adequate against the lowest levels of design threat we are considering in GESMO. (January 19, 1976 memorandum from Carl Builder to Ronald Brightsen.)

The NRDC also cited the transcript of a meeting at which members of it and the NRC were present. The subject was the adequacy of domestic safeguards. Of particular concern was the NRC contention that two guards armed with shotguns and .38 caliber handguns could hold off an intruding group until reinforcements in the form of local and State law enforcement authorities could arrive.

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[1] Ibid., p. 150-151.

Also relevant to the question of whether guards could protect a facility until outside help arrived is the issue of how guards are instructed with respect to use of their weapons. A report prepared by the Safeguards Policy Committee of the Atomic Industrial Forum (a group representing the nuclear industry) and submitted for the record, contained a recommendation that:

> . . . any escalation of the use of force beyond [the use of handguns for the purpose of] self-defense would be the responsibility of the forces acting under Government orders . . . .[3]

The latter forces are envisioned to be local, State, or Federal police who have responded to a call for assistance. The quandary concerns how guards armed only with handguns to be used only in self-defense (as opposed to defense of the facility or nuclear material) could protect a facility or materials until such time as assistance from police is available.

Following the hearings the subcommittee requested the NRC to provide additional information concerning the ability of safeguards systems to protect against the threats of a kind considered by the NRC and described in section I of this report. In responding on July 20, 1976 the NRC indicated that 15 facilities, in which plutonium or highly enriched uranium were handled, had been evaluated with regard to their effectiveness against threats, as noted in section I, consisting "at a minimum, of three well-armed, well-trained persons, who might possess inside knowledge or assistance." This review found security deficiencies in each of the 15 facilities. A subsequent review found deficiencies in 7 of the 15 facilities. Security systems at reactors apparently were not inspected with regard to their ability to withstand threats of the kind specified above. It is unclear from the NRC response whether security required during transportation is sufficient to protect against the specified threat. (The July 20 letter is attached to this report as appendix B.)

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[3] Ibid., p. 338.

V. CONCLUSIONS

Testimony presented before the subcommittee on security in the domestic nuclear industry was contradictory in many respects. There was little agreement as to the nature and severity of the danger, and the motivations of those who might engage in nuclear malevolence. Witnesses were not in agreement with regard to the intrinsic vulnerability of reactors to sabotage undertaken for the purpose of causing a large release of radioactive materials into the environment. Similarly there was no concensus concerning the degree of difficulty in protecting nuclear materials against theft.

In spite of such a wide disparity in viewpoint (and to some extent because of it) several conclusions can be drawn from the subcommittee hearings and subsequent correspondence:

1. Neither the nature of the threat, nor motivations of threatening groups or individuals is sufficiently understood. It is prudent, therefore, to design physical security systems on the basis of threats substantially in excess of those for which there is clear evidence.
2. A substantial discrepancy exists between the kinds of security dangers the NRC believes to be plausible, and the kinds of security measures required to protect against such dangers.
3. While nuclear reactors can be designed with an exceedingly high invulnerability to sabotage of a kind that would result in release of substantial quantities of radioactive materials into the environment, it is not clear that such invulnerability has been achieved in practice.
4. In view of intrinsic limitations on material measurement techniques, the role of material accounting systems in the overall safeguards process needs to be better defined.

APPENDIX A

GOVERNMENT OPERATION OF NUCLEAR MATERIAL TRANSPORTATION SYSTEM

Testimony was heard relating to the question of whether commercial carriers could provide adequate security for shipments of Government-owned materials which might be fabricated into nuclear weapons. Prior to 1975 some such materials were shipped via commercial carriers that were required to operate in accordance with AEC regulations. Late in 1974, the AEC decided that Government-owned materials being transported by private carriers—which included plutonium used in the breeder reactor development program and highly enriched uranium destined for naval reactors—should be transported by a Government system as soon as the Government obtained new vehicles designed for this purpose. At the time this decision was made, the AEC was already using its own transportation system for shipments of nuclear materials associated with the weapons program.

The immediate significance of this decision was in the displacement of commercial carriers who under contract to ERDA were currently involved in transportation of Government-owned materials. The longer term significance is that the same logic leading to this decision could lead to a determination that adequate protection of privately owned materials in transit would also require a Federal transportation system in place of private carriers. While at present the number of shipments of privately owned materials is small, that number would increase substantially were the NRC to permit the use of plutonium as a reactor fuel. A Federal takeover of this element of the industry would therefore represent a major move by the Federal Government in an area traditionally reserved to the private sector.

With regard to the possibility of the latter, Mr. Harvey E. Lyon, Director of ERDA's Division of Safeguards and Security, testified:

> I know of no decision arrived at by either the Nuclear Regulatory Commission or ERDA at the present time for transporting privately owned material.[1]

Frank Graham of the Atomic Industrial Forum testified that the Forum's Safeguards Policy Committee was of the opinion that:

> Private equipment and guards operating under Government orders would provide appropriate security assurance.[2]

Whatever the eventual decision regarding transport of privately owned material, the current AEC/ERDA decision that Government-owned material be transported via a Government system was criticized by Samuel Edlow, president of Edlow International, Inc. which acts as agent for shippers of nuclear materials:

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[1] Ibid., p. 516.
[2] Ibid., p. 338.

> We deplore and protest the ERDA plan under which at this very moment a Government transportation network has already replaced private industry as a carrier of nuclear materials, and which now threatens to expand to that point where all of us are driven out of business in favor of a Government-owned and operated transportation monopoly.[3]
>
> * * * * * * *
>
> The very thought that the Government functions better than private industry as a security organization is wrong, and is not based on facts. The attempt on the part of Government; namely, ERDA, to usurp the security function of private industry must be stopped. The rights of small business enterprises must be protected, and we believe they will be.[4]
>
> * * * * * * *
>
> Let me make it abundantly clear, Mr. Chairman, that we believe that the Congress and the executive have, wittingly or unwittingly, violated the very spirit of the free enterprise system by sponsoring and supporting the replacement of the private enterprise system by a Government-owned-and-operated monopoly.[5]

On April 27 the subcommittee sought a more complete explanation from ERDA concerning the basis for its determination that Government-owned materials should be transported by the ERDA transportation system. On June 29, 1976, ERDA informed the subcommittee that a response to its request would be delayed owing to the need to respond first to a request for information from the Office of Management and Budget on the same matter. The OMB had asked ERDA "certain questions and for certain analysis with respect to the (ERDA transportation) system's expansion to handle the nonweapons SNM (strategic nuclear material)."

The subcommittee received from ERDA on August 30, 1976, the following response to its April 27 request:

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION,
Washington, D.C., August 27, 1976.

Hon. MORRIS UDALL,
House of Representatives.

DEAR MR. UDALL: On June 29, 1976, I wrote to you at Dr. Seamans request concerning the plans of the Energy Research and Development Administration (ERDA) to extend the coverage of its existing transportation system for highway movement of nuclear weapons to include shipment of strategic quantities of ERDA-owned special nuclear material (SNM).

The decision to include shipments of nonweapons SNM was made by the Atomic Energy Commission (AEC) on August 2, 1974. On March 29, 1976, after thorough reexamination, that earlier decision was reaffirmed by the Administrator of Energy Research and Development. In reaching this decision, the Administrator determined that the most effective and efficient security would be provided by expansion of the existing ERDA system's shipments to cover all strategic quantities of ERDA-owned SNM, and that this security was essential considering the large number of shipments involved.

The decision to enlarge the coverage of our ERDA highway transportation system was reached only after careful review of all the factors of comparison between an integrated Federal system and one which would include some degree of commercial participation. While ERDA remains firmly committed to a policy of reliance on the private sector to supply its needs and provide its services, we are convinced in this particular case that there is a compelling basis for the judgment that ERDA can best fulfill its responsibilities for transporting weapons and strategic quantities of Government-owned SNM with the required degree of safety and security by using its own unified, single-manager transportation system. Among the factors supporting this judgment are: the added deterrent effect associated with a recognized Federal force; the enhanced authority to command and control the integrated transportation system and the individuals operating that system; the inherent planning and operational flexibility in a single, unified weapons/SNM system; the improved cost effectiveness, management, and manpower utilization of such a dual-purpose system; the consistency of policy and procedures employed for each operation; the increased effectiveness of coordination and cooperation with State, local, and other Federal agencies, including the DOD; the possible greater potential responsiveness of Government-employed personnel to ERDA direction in an emergency; the advantages of using guards trained for the protection of weapons for SNM shipments as well; and the assurance that shipments related to military requirements would not be adversely impacted by potential strikes or strike threats.

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[3] Ibid., p. 503.
[4] Ibid., p. 507.
[5] Ibid., p. 507.

In summary, in reaching decisions concerning our ERDA transportation responsibilities, we have been acutely aware of the need to optimize the security of the transportation system. The potential for serious consequences—should the security of SNM prove inadequate—is so great that we feel a strong obligation to achieve maximum assurance that ERDA has done all it can to protect its shipments of SNM as well as weapons. We believe our planned system accomplishes this in the most effective and efficient manner.

Earlier this year, the Edlow International Co., a transportation management contractor who obtains transportation services by subcontracting, requested the Office of Management and Budget (OMB) to review this matter and the basis for the policy of using the all-Federal transportation system planned by ERDA. In this connection, the OMB asked ERDA to provide an economic analysis comparing the Federal system with alternatives which involved varying degrees of participation by private industry. ERDA provided informally to the OMB on July 7, 1976, the final version of the analysis requested. The analysis showed that the Federal system, with its coverage extended to SNM shipments, could be operated more economically than options involving a split Federal/contractor approach. After its review of the analysis, the OMB informed ERDA on August 23, 1976, that it supported the decision of the Administrator of ERDA. In view of the OMB action, we are proceeding to complete the implementation of our plans for a unified Federal (ERDA) transportation system, to include movement of the SNM referred to above, by October 1976.

In your letter you also inquired regarding what bearing our determination might have on possible subsequent requirements of the Nuclear Regulatory Commission (NRC) with respect to transportation of strategic quantities of privately owned nuclear materials. In this regard, it is the clear position of ERDA that its decision is not intended to influence future actions by the NRC, nor should it be regarded as so doing. The ERDA decision stands alone on its own merits and has been arrived at using a particular set of circumstances and factors unique to ERDA. We believe that another Federal agency, such as the NRC, could reach different determinations based on different requirements and considerations. Such determinations might not include a Government-owned transportation system as a necessary feature of providing adequate security. We do not believe that the decisions by ERDA should be regarded as constraining to the NRC; and, in particular, we do not believe the actions being taken by ERDA to protect its shipments should govern whatever actions the NRC might subsequently direct regarding shipments of privately owned materials.

I should be pleased to inform you further on this matter should you so desire.

Sincerely,

ALFRED D. STARBIRD,
Assistant Administrator for National Security.

APPENDIX B

U.S. NUCLEAR REGULATORY COMMISSION,
Washington, D.C., July 20, 1976.

Hon. MORRIS K. UDALL,
Chairman, Subcommittee on Energy and the Environment, Committee on Interior and Insular Affairs, U.S. House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: In your letter of April 20, 1976, you stated that it was not clear whether the Nuclear Regulatory Commission believes it necessary to protect against threats discussed by Mr. Builder in his January 19, 1976, memorandum and by Mr. Chapman in his February 27, 1976, testimony.

In January 1976, the NRC began a special review of safeguards focusing on licensees who possess significant quantities of highly enriched uranium or plutonium. Onsite evaluations were made to assess the effectiveness of programs approved and implemented to meet current regulations and to judge safeguards capabilities against postulated threat levels. The capabilities of 13 licensees (involving 15 facilities) were examined. Although there are no specific threat levels defined in our regulations, the threat levels used for this review consisted of an internal threat of at least one employee occupying any position and an external threat comprised, at a minimum, of three well-armed, well-trained persons, who might possess inside knowledge or assistance. Licensee safeguards capabilities were expected to defeat this threat with high confidence.

This special review focused on fuel cycle facilities possessing strategic quantities of special nuclear materials. For safeguards purposes, this is defined as at least 2 kilograms of plutonium or 5 kilograms of uranium-235 (contained in uranium enriched to more than 20 percent in the U^{235} isotope).

Weaknesses relative to the threat levels used in this review were found at each of the 15 facilities. The most prevalent weaknesses related to control of access to significant quantities of special nuclear material (both stored and in process), exit search procedures, and adequacy of response by onsite and offsite forces. The review teams indicated that short-term fixes could correct most weaknesses and that some could be resolved by procedural changes alone. On-the-spot followup actions were initiated to correct weaknesses found.

During the initial review, guard forces of some licensees were judged inadequate because of their stated reluctance to engage an attacking force or because of their lack of strength in numbers. Since then, one licensee has significantly increased his guard strength, two others have hired more watchmen and all licensees have affirmed their commitment to intervene to protect strategic quantities of special nuclear material.

On the basis of a special survey by inspectors in the NRC regional offices, it has been determined subsequent to the review mentioned above that all licensees have made significant improvements in their safeguards systems. Of the 15 facilities involved in the safeguards review, 8 facilities were judged to be adequate to withstand both the external and internal threats defined in the second paragraph of this letter. Of the remaining seven, one was judged adequate to protect against the external threat but not the internal threat, four were judged adequate to defend against the internal threat but not the external threat, and two were judged not adequate to protect against either threat with high confidence.

Correction of safeguards deficiencies by licensees is presently being accomplished by NRC staff using existing inspection, enforcement, and licensing procedures.

Through the combination of voluntary licensee corrective actions and new license conditions, all fuel cycle licensees are expected to have the capability to withstand as a minimum the internal and external threats defined in the second paragraph of this letter by August 1976. To determine that this capability has been achieved, NRC assessment/evaluation teams will review again all fuel cycle facility safeguards measures onsite during August-September 1976.

In a separate series of reviews, the NRC staff has been analyzing the vulnerability of road shipments of strategic quantities of special nuclear materials to attack by one internal and three external adversaries having military training and skills. These reviews, conducted with industry cooperation and assistance from U.S. Army special forces teams have already led to improvements in commercial transportation planning and scheduling and in the training of drivers and guards. Furthermore, based upon these reviews, the NRC staff has implemented new license conditions requiring increased protection for strategic quantities of special nuclear material in transport.

Nuclear reactor facilities were not included in the safeguards reviews discussed above. However, special physical security inspections have been conducted during the period February-May 1976. These inspections indicate that guard forces at certain reactor sites have recently been upgraded in anticipation of a pending amendment to the reactor safeguards regulations.

With regard to civil penalties associated with safeguards activities, the first penalty for noncompliance was assessed in August 1974. Since then, safeguards civil penalties have been assessed against 14 licensees and 3 are presently pending. Only one licensee has received two civil penalties for noncompliance with safeguards regulations.

In reply to your questions concerning the utility of monetary civil penalties, it should be noted that civil penalties are only one of several sanctions utilized in our enforcement program. In addition to civil penalties, the NRC has authority to modify, suspend, or revoke licenses. In general, these sanctions are considered to be more severe than civil penalties, although the ranking is not a clear-cut one. In terms of impact on a licensee, we generally consider that the most severe sanction is that of revocation of the license, thus denying the firm the ability to perform the activity subject to the license. The selection of which enforcement sanction to be applied in a particular case is one of the responsibilities that the NRC must discharge. All of the various enforcement sanctions available to the NRC have been used in the past and, as necessary, they will be used in the future to obtain needed corrective action.

The NRC staff is initiating a study to examine, in more detail, the effectiveness of the various enforcement sanctions available to it. This study is expected to be completed before the end of this year.

I hope this letter has clarified these nuclear safeguards matters for you. Please let me know if the Commission can be of further assistance to your subcommittee.

Sincerely,

MARCUS A. ROWDEN,
Chairman.

Nuclear Proliferation, Motivations,
Capabilities and Stategies for Control
(Excerpt)

THREE

Principles for Effective Safeguards

In the face of this drift and of the present inadequacies of national and international safeguards, we believe that the world should establish, with a sense of utmost urgency, as effective as practicable safeguards against both criminal and national diversion. The objectives of such a system have been implicitly derived in the preceding section; they can, we believe, be usefully formulated as a set of guiding principles. The first two principles focus on the problem of criminal diversions, the final three on the problem of nuclear proliferation.

1. *All weapons-grade material, whether at fixed sites or in transport, should be effectively protected against criminal theft or diversion through the use of techniques that are open to inspection and assessment by all interested nations.*

International safeguards as now structured permit commerce in weapons-grade material unencumbered by physical security arrangements other than those imposed by individual nations. There are no existing measures that translate the international community's clear interest in every nation's physical security system into concrete international arrangements. This principle insists, by contrast, that national systems of physical security over weapons-grade material should be monitored by the international community. Thus not only would states have to meet minimal international standards, but they also could be relatively confident that other states were also conforming.

2. *Internationally managed physical security safeguards, nevertheless, should not be required at national facilities.*

   This principle recognizes the generally strong resistance of countries to any actions that suggest infringement of national sovereignty over internal law enforcement. Since reactors are by far the most numerous of nuclear facilities as well as the fuel-cycle component that countries are most reluctant to site outside of their boundaries, the principle implies that reactors should be designed to minimize the problem of physical security at and en route to reactor sites.

3. *All nuclear materials for civilian use, and from which weapons-grade materials can be derived, should be kept within authorized channels defined by specific physical boundaries, and any transfers of strategic quantities of these materials outside these boundaries must be promptly detected by an IAEA or equivalent international safeguards system.*

   This principle reflects the essential objective of the current international safeguards system. This system can at best hope to detect diversions of material; it is not designed, nor can it expect, to prevent diversions.

   The physical boundaries need not necessarily be stationary. They might include, for example, the containers or vehicles used for transportation of safeguarded nuclear materials. For the present, we define "strategic quantities" to be such that the contained quantities of ^{235}U, plutonium, or ^{233}U be more than 5 kilograms, 1 kilogram, and 1 kilogram, respectively. By "promptly" we mean essentially at the time any unauthorized movement out of authorized channels takes place. This implies that emphasis would be placed by the IAEA on direct surveillance by instruments or inspectors of credible points at which such transfers might take place and that materials accounting procedures would be used to *supplement* the prompt detection techniques.

   Instruments now exist that under some conditions could, in a few seconds or less, detect as little as a few grams of weapons-grade material moving through a doorway or other penetration of a physical boundary. In some situations, accurate materials accounting systems could also detect diversions of less than strategic quantities of nuclear materials. We therefore argue that any detected, unauthorized transfers of *less* than strategic quantities also be recorded by the

IAEA and if analyses of these quantities over time indicate that more than a strategic quantity has been diverted from a particular facility, that this be reported by the IAEA inspectorate to the Agency's Board of Governors.

4. *The activities intrinsic to civilian nuclear programs within a country should be as distinct as possible from activities that the country would have to undertake to produce nuclear weapons.*

   This principle emerges from considerations of latent proliferation, that is the tendency of some types of civilian nuclear power programs automatically to lessen the time and technical effort required for the actual production of nuclear weapons.

5. *All safeguards measures and restrictions on access to specific civilian nuclear technologies should be equitably applied to all countries.*

   We believe it illusory to suppose that a safeguards system can long persist that formally denies some aspects of *civilian* nuclear technology to certain countries while permitting them to others and that otherwise imposes safeguards obligations discriminately. Beyond the asymmetric safeguards obligations that now exist under the Non-Proliferation Treaty between the nuclear weapon states and the non-nuclear states, there are increasing international efforts to discriminate between classes of non-nuclear countries. Several of the industrialized countries with the strongest indigenous programs of civilian nuclear power hope to deny technologies that they themselves plan to develop (such as reprocessing plants) to as many other countries as possible. Still more discriminatorily, several of these nuclear suppliers have sometimes sought or have felt obliged by prior commitments to make distinctions on a country-by-country basis. The United States and other suppliers are prepared to provide nuclear assistance to India and South Africa, which are nonsignatories of the NPT, but are not willing to do so to some countries that are parties to the Treaty. These distinctions are not necessarily unreasonable as a short-term expedient, but they do not form a basis for an enduring, stable policy. They will eventually seem unfair and unpersuasive to supplier countries as well as to the countries denied assistance.

   There is, of course, a deep inequity intrinsic to any nonproliferation strategy, between the countries that have nuclear weapons and the countries that are to be denied them; and in the long run, we doubt that any strategy to impede proliferation can succeed without directly confronting the nuclear weapons already in existence. We do believe, however, that schemes of control on civilian nuclear power that build an international equity into at least this limited sector and that construct a significant reliance on international institutions will provide useful bridges to the more far-reaching international arrangements affecting nuclear weapons that will eventually be necessary.

Nuclear Power Issues and Choices
Report of the Nuclear Energy Policy Study Group

(Excerpt)

SAFEGUARDS

Safeguards over the use of indigenous or imported nuclear material or facilities play an important but limited role in preventing proliferation. They do not in themselves limit the capability to make nuclear weapons; they do not prevent misuse of nuclear capabilities or prevent proliferation. Nevertheless, they do help deter proliferation and create an international atmosphere in which a nonproliferation regime is possible.

Safeguards presuppose the operation of a system of national accounts and reports for nuclear materials. IAEA inspectors have access for verification to accounts, materials, and facilities. Safeguards are thus an alarm and a reassurance. As an alarm, they deter by the threat of timely discovery. And they offer the opportunity to demonstrate observance of commitments, and thereby to reinforce arrangements and build mutual confidence.

Safeguards are not foolproof. There are technical problems in maintaining and verifying accounts even within a national program. IAEA safeguards do not protect facilities or material from attack or seizure. International safeguards operate within painfully negotiated and rigidly defined procedures, constrained by sensitivities of national sovereignty. Efforts to install better technical and procedural measures and improve the skill and access and number of inspectors are important, are worth additional funding, and should yield results. Opening of extensive U.S. and United Kingdom nuclear power facilities to IAEA inspectors, now being worked out with the IAEA, will undercut resistance to inspection and safeguards justified on grounds of discrimination; similar action by the Soviet Union should continue to be sought.

Safeguards over sensitive fuel cycle facilities such as reprocessing plants, enrichment plants, and storage of separated plutonium (including that in mixed oxides) or highly enriched uranium pose particularly difficult problems. Even with a staff of full-time inspectors, there could be little confidence that diversion of enough plutonium for a single explosive could be detected, although material for a significant number of weapons would be more detectable. However, full-time inspectors could probably assure that a low-enrichment facility was not being reconfigured or operated to produce highly enriched uranium. International operation of such facilities would be more effective in preventing diversion at the facility itself.

Under the NPT, safeguards are to be applied to *all* peaceful nuclear activities in the territories of nonnuclear weapon NPT parties. In the case of nonparties, safeguards are applied only to materials or technology imported from NPT parties or others requiring safeguards. This element of discrimination between

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parties and nonparties has been troublesome to some-states. The United States and other NPT parties should seek to have all states become parties to the NPT, and in the interim to have all activities subject to safeguards.

Should exports of materials or technology for peaceful programs be withheld unless one or the other of these conditions is accepted? There may be cases where the wiser course is to work with nonNPT states, to insist on IAEA safeguards on all supplies of materials and technology and their by-products or derivative applications, and to draw these states and their programs as extensively as possible into safeguards and commitments against explosives use. A de facto nonproliferatoin regime would then apply. Violation or abrogation of arrangements would then be subject to penalties. A pattern of peaceful cooperation and of interdependent safeguarded activities might come to prevail throughout their atomic energy programs.

IAEA sanctions are limited. In case of violation, the agency can (1) notify nuclear countries and the UN Security Council; (2) suspend the state in question from IAEA membership; and (3) demand the return of agency-supplied materials. Members are reluctant, however, to invoke even disclosure and investigation because of the political opposition which might ensue. For the latter deficiency, provisions for resolution of unclear cases–perhaps through use of a nonpunitive investigative and conciliation committee of the IAEA Board–would reinforce confidence in the efficiency of the safeguards system. For actual violations, action by major members (who will be major suppliers and thus have substantial leverage) will be imperative.

INTERNATIONAL SAFEGUARDS OBJECTIVES, STATUS AND UNRESOLVED ISSUES

THE INTERNATIONAL ATOMIC ENERGY AGENCY VIEW

Rudolf Rometsch
Department of Safeguards
International Atomic Energy Agency

ANS Executive Conference, Cape Cod, Massachusetts
October 16 - 19, 1977

Safeguards, in the sense of international measures to detect and thereby deter the diversion of nuclear material to military uses, atomic weapons and other nuclear explosives, are still the central element of non-proliferation measures. In fact, safeguards are the only non-proliferation measure based on international co-operation. The efforts of nuclear supplier countries to establish a common policy with a view to widening the scope of safeguards have developed quite independently from IAEA. Although at the origin international safeguards were largely triggered by export conditions, and this is still true for certain cases to-day, there appears to be a gap between the present safeguards efforts based on international treaties and those non-proliferation measures the main suppliers attempt to enforce. Endeavours to close this gap are under way. However, before a more complete package of non-proliferation measures will be effective a number of international understandings in addition to those realized in the work of the International Atomic Energy Agency have to be achieved. They must necessarily lead to an extension of the mandate of the IAEA, or the addition of further international conventions which go beyond those at the basis of the IAEA work.

Before discussing non-proliferation measures beyond the present international safeguards it is essential to analyse the network of present safeguards agreements, to understand its limitations and constraints.

The Non-Proliferation Treaty provides to-day the most relevant basis for the conclusion of safeguards agreements. 99 non-nuclear weapon states have now acceded to that Treaty, which requires them to conclude a safeguards agreement with IAEA covering all their peaceful nuclear activities. 51 States have done so; they include the majority of States having a highly developed nuclear industry. Seven of them (Belgium, Denmark, Ireland, Italy, Luxembourg and the Netherlands) have concluded the safeguards agreement jointly with IAEA and the European Atomic Energy Community in accordance with Article III.4 of NPT.

Although NPT safeguards agreements with Japan, Switzerland and Venezuela are not yet in force, all nuclear activities in these States are already subject to safeguards as a result of the operation of other agreements; this applies also to Taiwan. Negotiations are in train with most of the NPT countries that have not yet concluded the required agreement. Except in the three cases mentioned the NPT safeguards agreements that have not yet entered into force are with States that have not any significant nuclear activity. In those States the application of safeguards is being held in abeyance; full application will begin as soon as nuclear material or a plant requiring safeguards is acquired in the State concerned.

The IAEA applies safeguards in 13 States that are not Party to the NPT. In eight of them all significant nuclear activities are subject to safeguards; the exceptions are India, Israel, South Africa and Spain. According to the best information available to the IAEA Secretariat, the only non-nuclear weapon

State which has a significant nuclear activity and where no IAEA safeguards are yet applied is Egypt.

Only a few of the non-NPT States are likely to accede the Treaty in the not too distant future. The others represent a group of political resistance to the Treaty, even when in some of them at present all nuclear activities are subject to safeguards agreements with the IAEA. The essential difference between those safeguards agreements and the agreements in connection with the NPT is that their scope is limited to defined nuclear activities, namely, those based on imports or derived from imports.

The picture of the network of safeguards agreements would be incomplete without mentioning safeguarding in the nuclear-weapon States. Of the three depository States of NPT the United Kingdom and the United States have negotiated safeguards agreements pursuant to voluntary offers; these agreements are not yet in force. Their purpose is to enable the IAEA to apply safeguards to all nuclear installations except those related to national security. At present safeguards are already applied in these States under trilateral agreements to cover, e.g., reprocessing of irradiated fuel shipped from other States. Negotiations on a similar agreement as the one with United Kingdom will begin with France in a few weeks; France is not Party to NPT but adheres, in accordance with a declaration made in 1968 to its non-proliferation objectives.

Since the coming into force of the Non-Proliferation Treaty and the connected safeguards agreements essential progress has been made with regard to the technical implementation of safeguards, the clarification of their technical objectives and quantification thereof.

The attitude of the international Community to the IAEA's safeguards work has at the same time undergone quite some changes. These developments and the constraints to them will be discussed tomorrow in connection with the IAEA's safeguards programme. I would now like to describe the efforts to improve the network of safeguards agreements and then discuss possible non-proliferation measures beyond the present safeguards mandate of IAEA.

At the Non-Proliferation Treaty Review Conference in Geneva in May 1975 there was a large majority of delegations supporting the concept that NPT States should export nuclear material,equipment and technology only to other NPT States or States having concluded a so-called full scope agreement which covers all nuclear activities. This was also advocated strongly by the Director General of the International Atomic Energy Agency. It was finally not possible to achieve unanimousness of the NPT-States on this issue. There were important nuclear supply and exchange contracts in the final stage of negotiation which were not based on this concept.

The discussion in Geneva remained, however, not without effect. The work of the so-called London Suppliers Club was initiated by the Conference urging that "in all achievable ways common export requirements relating to safeguards be strengthened in particular by extending the application of safeguards to all peaceful nuclear activities in import states not party to the Treaty". There was also a marked influence on the negotiations of important trilateral safeguards agreements, namely, the one between the Federal Republic of Germany, Brazil and IAEA and the one France/Pakistan/IAEA.

In both these agreements the extension of safeguards to facilities and equipment constructed in the importing State on the basis of technical know-how transferred together with nuclear supplies was carefully formulated. The difficult part of this type of safeguards coverage lies in the method used to assure that the IAEA is made aware of facilities derived from imported technology. Various clauses are used to involve the supplying State in the notification procedure. In the Brazil/Federal Republic of Germany/IAEA agreement, for instance, it was added that "the contracting Government of the State from which relevant technological information had been transferred is under the obligation to consult promptly the other contracting Government if in the view of the former there is reason for a notification to the Agency".

This type of clause, assuring that nuclear facilities constructed on the basis of transferred technology are subject to safeguards, represents an important step in the direction to full scope safeguards agreements. It is, however, only applicable to new agreements. Those old safeguards agreements concluded outside NPT, which led to the transfer of technology together with facilities and subsequently to the construction of copies of the nuclear facilities which are not subject to safeguards, can unfortunately not be corrected retroactively. The limited scope of safeguards agreements outside NPT remains an unresolved issue, although the non-proliferation bill emerging from Congress will, of course, require full scope safeguards for US exports, at least in case of new agreements.

A number of Non-NPT States have explained why and that they cannot become party to the NPT, but they have not refused the idea of full scope safeguards. The Agency's Board has decided two years ago that a model safeguards agreement should be worked out covering all nuclear activities in a State and based on the pre-NPT safeguards system of the IAEA. Several Non-NPT States planning significant nuclear activities are considering this type of safeguards agreement. It has not yet been possible to conclude such an agreement.

Summing up the situation with regard to safeguards agreements it must be stated that about 10% of the nuclear activities in non-nuclear-weapon States remain not covered, that 14 States have started significant nuclear activities and have not (or not-yet) requested to cover all of them by safeguards agreements, thus keeping options open, and that two nuclear-weapon States do not accept safeguarding of their civil nuclear activities.

Besides those limitations of international safeguards due to lack or incompleteness of agreements there is also recognition of limitations of safeguards as non-proliferation measures. They are twofold: diversion detection safeguards cannot provide diversion prevention except for some "deterrence by early detection" and they do not assure any control over the production and accumulation of weapons grade material.

Diversion prevention - in this country included or often meant exclusively by the term "safeguards" - lies beyond the action mandate of IAEA. At the Agency we subsume all diversion prevention measures under the term "physical protection". They have to be realized by national authorities. The Agency has worked out, with the help of a group of international experts, recommendation on "The Physical Protection of Nuclear Material" which were first published in 1972. They have been revised twice, in 1975 and in 1976. The latest revision was published under the document code INFCIRC/225 (corrected).

The studies by the IAEA Secretariat and by the expert working groups dealing with the recommendations brought again and again to light that on the international level physical protection questions are difficult to handle, that the international legal instruments are missing. This is an unresolved issue. The Agency is providing organisational support and making available its facilities to the Member-States for a two weeks meeting on this subject which will begin at the end of this month. A "Draft Convention on the Physical Protection of Nuclear Materials, Facilities and Transports" has been prepared by the United States of America and sent to the IAEA Member States. It will be used as a working paper at the meeting, together with comments and proposals made by other Member-States.

The IAEA's General Conference has last month accepted a Resolution commending these efforts, urging continuation and requesting the Director General to report on the progress made in this matter at the next General Conference.

Finally, an essential unresolved issue with regard to non-proliferation is the international management of special fissionable material. Even the strictest international diversion detection safeguards do not, and are not meant to, prevent accumulation of safeguarded weapons grade nuclear material. As a reaction to this fact it is often stated that international safeguards cannot be effective. This is a crude oversimplification. The crux of the matter is that safeguards are an essential non-proliferation measure, but must be complemented in order to make a fuel cycle proliferation-resistant in which large quantities of e.g. plutonium are handled.

As a radical solution it has been suggested to limit the expansion of the peaceful nuclear fuel cycle, e.g., avoid completely reprocessing of plutonium bearing spent nuclear fuel. There is, however, an awareness that such measures might impede development or encourage independent nuclear fuel cycles instead of furthering international co-operation in this field.

The constructive alternative is to render the plutonium cycle much more proliferation resistant by measures additional to safeguards. A package of non-proliferation measures is suggested based on fuel cycle optimisation. The optimum aimed at is to use up the plutonium in the same rythm as it is produced and separated.

The technical basis for such optimisation is evidently more easily achieved when there are only a few large reprocessing plants with which the re-fabrication of plutonium bearing fuel is co-located. Hence the idea of creating regional fuel cycle centers. In such centers it is not only easier and more effective to assure the best possible physical protection of the nuclear material and to implement in good co-operation with the plant management the most effective international safeguards, but it is then also possible to manage the fuel cycle in such a way as to minimize the need for intermediate storage of weapons grade plutonium. In fact, the understanding between the partner of such a joint venture could go easily as far as fixing a low quantity of separated plutonium, e.g., 50 kilograms which would not be exceeded by the inter-connected operation of the co-located facilities.

Whenever for operationsl reasons the accumulation of special fissionable material goes beyond such fixed limits, as a third measure, depositing in a specially protected storage under IAEA custody should be foreseen. Statutory provisions exist but corresponding practical regulation would have to be developed and accepted by international understanding.

For the setting up of a complete set of such non-proliferation measures political understanding between the parties involved is a pre-requisite and the effective implementation is conditioned by maintaining the spirit which led to the basic understanding. It appears now possible that such understanding can be reached in the frame of the International Fuel Cycle Evaluation Program to be undertaken by a Group of States. The non-proliferation measures to be imposed on the plutonium cycle cover most of the short-term issues of this programme. The IAEA, in view of its safeguards responsibilities, is interested in these plans and is preparing its participation in the hope that it will soon be possible to remove a number of additional non-proliferation measures from the list of unresolved issues.

1977-10-12

(Excerpt)

REPORT TO THE CONGRESS

UNITED STATES GENERAL ACCOUNTING OFFICE

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

An Evaluation Of The Administration's Proposed Nuclear Non-Proliferation Strategy

The administration's non-proliferation strategy, as outlined in the President's policy statement and the executive branch's proposed legislation, is generally constructive. There are, however, some weaknesses which the Congress and the executive branch can and should address.

ID-77-53

OCTOBER 4, 1977

EXCERPT

CHAPTER 3

STRENGTHENING INTERNATIONAL SAFEGUARDS

International safeguards rely on material accountability complemented by containment devices and surveillance. The task is to apply such safeguards with a high degree of reliability and assurance within acceptable cost limits and without unduly interfering with commercial operations.

International Atomic Energy Agency safeguards are designed only to detect diversion on a national level, and it is assumed that member nations will protect nuclear material from terrorist or subnational groups. These safeguards do not encompass physical protection, safe international transport of nuclear material, or nuclear waste. Moreover, the IAEA does not have the authority to seek out undeclared or clandestine nuclear facilities or stockpiles of nuclear material.

Congressional concern over safeguards was evidenced by extensive hearings during the 94th Congress. As a result, the 1976 and 1977 appropriation legislation for International Organizations and Programs required that not less than $1 million of each year's appropriated funds be used to strengthen the IAEA safeguards program. President Ford, in October 1976, directed ERDA and the Department of State to undertake a major effort to upgrade IAEA technical safeguards capabilities.

In November 1976, the United States initiated a renewed effort to strengthen the effectiveness and credibility of the IAEA safeguards system by providing financial and expert assistance. A number of projects were identified to (1) provide training, (2) upgrade equipment and procedures in material inventory verification, (3) expand containment and surveillance technology, (4) help achieve comprehensive, accurate and timely reporting, (5) assure that data generated by inspectors is properly analyzed, and (6) improve the effectiveness of the application of IAEA safeguards.

SAFEGUARDS ISSUES TO BE ADDRESSED

The administration's proposed legislation would commit the United States to a strengthened and more effective IAEA and to a comprehensive IAEA safeguards system. The legislation calls for the United States to work with other nations to strengthen the IAEA by contributing technical resources and funding, improving the safeguards system, and assuring that IAEA receives the necessary data to administer an effective comprehensive international safeguards system. This is merely a codification of the current effort.

Other issues should also be addressed, such as:

--Whether IAEA can effectively use increased U.S. financial assistance.

--The lack of empathy some countries have for safeguards.

--The reliance on international safeguards without sufficient assurances that they are effectively applied.

--The weaknesses in the U.S. safeguards (material accountability) system. This system has been used in large measure as a model for international safeguards.

--The need for a greater role for IAEA in improving physical security provided for nuclear material around the world.

Financial problems

The United States now provides substantial in-kind assistance [1] to IAEA beyond what the Agency recognizes as its current requirements for regular operations. The IAEA, moreover, may not now have the ability to effectively absorb further substantial increases in U.S. monetary and in-kind assistance.

There are no reliable projections on how much IAEA safeguards or other programs will cost beyond 1978 because of uncertainties in the quantity of material and the type of facilities to be safeguarded and the intensity of the safeguards to be applied.

There is also considerable concern within the IAEA membership that if safeguards funding is increased there might be pressure to also increase nuclear-related technical assistance to the developing countries. These factors hinder the ability to project what future costs must be borne by the United States and other members to adequately fund IAEA, especially for an effective safeguards program.

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[1] Equipment, training, fellowships, and research.

Political problems

Effective safeguards depend in large measure on the intent and cooperation of the nation to which they are applied as well as on the adequacy of technological control and implementation. Thus, technological control in the absence of genuine political commitment is inadequate.

The lack of empathy in some countries for safeguards is shown in many ways. For example, some countries may limit the number of inspectors by not accrediting as many as IAEA may deem desirable while some might exclude or limit the use of certain surveillance and containment devices (cameras and seals) in their facilities. In addition, proprietary concerns in some countries may make it difficult to apply techniques or use instrumentation in the best and most efficient manner.

Efforts to strengthen safeguards on nuclear material may be viewed by recipient nations as a political move on the part of the nuclear suppliers. The IAEA Secretariat has indicated that many actions can contribute to controlling proliferation but IAEA safeguards might lose their effectiveness if they become a major element of controversy between the developed and developing nations.

Sanctions against proliferation

No system of proliferation controls is likely to be effective if a potential violator judges that the international community will be indifferent to a violation.

Certain international sanctions are built into the IAEA Statute for any breach of a safeguards agreement, but they are limited. These include a report to the U.N. Security Council and General Assembly, curtailment of IAEA assistance, and a call for the return of the material and equipment that the offending country has received and suspension of the rights of membership. These sanctions have never been employed, and it is unclear how nuclear material would be retrieved if the country were unwilling to voluntarily return it.

According to the IAEA Secretariat, the question as to what other sanctions would be appropriate is a matter for IAEA member states or NPT parties to consider. To serve as an effective deterrent, such sanctions should be known in advance, their application must be certain and automatic, and they must involve all major suppliers and preferably have the support of the international community as a whole.

The administration's bill would provide for U.S. sanctions against the violator of a nuclear agreement by halting U.S. nuclear exports to any non-nuclear weapons country that, upon enactment of the legislation, detonates a nuclear explosion, terminates or abrogates IAEA safeguards, or is found by the President to have materially violated an IAEA agreement. The President could waive such sanctions if they jeopardize common defense and security or hinder achievement of non-proliferation objectives.

Moreover, the bill calls on the President to seek to have all nations commit themselves to international arrangements or other mutual undertakings which would adopt general principles and procedures. This would include common international sanctions to be followed in the event a nation violates its obligation with respect to the peaceful uses of nuclear material or violates the principles of the NPT, including the detonation of a nuclear explosion by a non-nuclear weapons country.

The administration's proposal does not deal with sanctions for nuclear-weapons countries. Sanctions would be limited to halting nuclear exports for non-nuclear weapons nations. President Ford had indicated that this would be the minimum action taken. He announced in October 1976 that the United States would consider further steps against a violator nation and would not confine its actions just to violations of agreements in which the United States is directly involved. However, whether or not the current administration would go beyond halting nuclear exports has not been indicated.

U.S. reliance on IAEA safeguards

The United States has been promoting the concept of international safeguards throughout the world and has played an important role in the development of current IAEA procedures and techniques. Because IAEA is committed to restricting the dissemination of inspection information, neither the United States nor any other country receives sufficient information about the implementation of the safeguards to assess their reliability.

The administration's bill does not address this issue. We believe the United States should exercise leadership in ensuring that IAEA safeguards are adequately, fairly, and consistently applied and that all nations receive sufficient assurances that their trust in safeguards has not been misplaced. In commenting on our report, ERDA officials advised us that the executive branch has been trying to get such information from IAEA.

The IAEA Secretariat has indicated that in 1977 the Agency will prepare for its Board of Governors its first comprehensive report on the IAEA safeguards operations, covering only 1976 activities. Making such a report available to the member nations, would, in our opinion, be one way to provide needed assurances on the effectiveness of safeguards. Other ways should also be considered--external evaluations of safeguards activities could be made; reports on material subject to safeguards and unaccounted for could be issued; and, with the consent of the host country, inspection reports could be provided to the supplier nation.

NRC staff commented that current efforts to ensure access to information on IAEA safeguards implementation should continue to be actively pursued but that new methods for obtaining such information would have to be weighed against how such action may or may not adversely affect the overall efforts. The NRC staff believes that (1) publication of certain information could work against U.S. interests and (2) the United States should generally not review or evaluate IAEA inspection reports because it could undermine the mission and effectiveness of IAEA. The NRC staff, however, did not elaborate on its reasoning.

Impact of U.S. domestic procedures on international controls

The United States has espoused the need for IAEA to upgrade its safeguards program and for other countries to improve the physical security of nuclear material. International safeguards are based, in large part, on the U.S. safeguards system. Our reviews of the safeguards at U.S. Government facilities and commercial nuclear power plants 1/ showed that (1) there were significant shortcomings in ERDA's and NRC's ability to account for inventories of dangerous nuclear materials and (2) measures to physically protect these materials needed improvement. We concluded that the state-of-the-art of nuclear material accountability is such that it does not provide timely information on possible diversions.

The administration's National Energy Plan deals with improving some aspects of physical security but does not address the problems of domestic material accountability

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1/ Shortcomings in the Systems Used to Control and Protect Highly Dangerous Nuclear Material, July 22, 1976 (EMD-76-3), and Commercial Nuclear Fuel Facilities Need Better Security, May 2, 1977 (EMD-77-40).

and associated unaccounted-for balances. Accountability is the cornerstone of IAEA safeguards, and, if a technologically advanced, non-proliferation-conscious nation like the United States does not have its own safeguards (material accountability) program in order, training foreign nationals in U.S. safeguards techniques and providing financial and expert support as the administration proposes will not solve the problem of upgrading international safeguards.

Physical security

The administration would seek to get other nations to enter into international arrangements or mutual undertakings with the objective of establishing and maintaining adequate physical security measures by all nations on all of their nuclear activities. However, the proposed legislation does not provide for the establishment of international physical security standards nor for a mechanism to ensure that physical security measures are adequately implemented.

Most countries believe that the implementation of physical security is an individual nation's responsibility, involving internal police powers. However, physical protection of nuclear material has become such a global concern that the major nuclear suppliers are now requiring countries that buy nuclear materials to maintain adequate physical security.

The United States, for one, is conducting physical security reviews in the recipient country, and other suppliers may also decide to perform similar reviews for their exports. However, current U.S. agreements for cooperation do not include specific requirements or standards for physical security measures to be applied to U.S.-supplied material nor do they specify that the United States has the right to review physical security measures in the recipient country.

State Department and ERDA officials commented that in the agreements for cooperation the administration would not want to encourage a mandatory provision for physical security review rights even though the United States is already carrying out such reviews. NRC indicated that attempting to mandate such a review right could well prove counterproductive to cooperative review efforts already underway.

U.S. experience to date in conducting bilateral physical security undertakings apparently has proven acceptable. Moreover, the NRC staff considers that continued improvements in physical security can be fruitfully pursued through bilateral channels. However, just as the concept of maintaining bilateral safeguards was considered unworkable by the United States in the long term, we believe continued reviews of one country's physical security by another may be viewed in a similar light.

Physical security reviews by several suppliers may not be fairly and consistently made. With each supplier setting up its own criteria for deciding if a recipient country's physical security is adequate, there is a risk that one supplier might accept less stringent physical security precautions in order to promote its nuclear sales. Under such circumstances, the recipient may not know if security deemed adequate by one supplier will also meet another's criteria.

To assure that recipients' physical security measures are effectively maintained, we believe that IAEA should routinely review those measures during its safeguards inspections. Some of the potential advantages of having physical security reviews made by IAEA rather than by each exporting country are that:

--IAEA has developed physical security guidelines which serve as a model for member nations.

--IAEA could make physical security reviews as part of its regular safeguards inspection activities.

--Physical security measures would tend to be more uniform and would be continually subject to inspection.

--It would be more expensive, in the aggregate, for many supplier countries to perform duplicative physical security reviews than for one international organization to undertake the job.

--To rely on IAEA to perform physical security reviews would enhance its prestige, increase its responsibilities, and might make it more effective in its other efforts, including safeguards.

The NRC staff pointed out that, while there may be substantial advantages to an increased role for IAEA in the long run, physical security is a sensitive area and the potential value of increasing the IAEA's role would need to be carefully weighed against possible disadvantages, political realities, and practicalities.

The State Department and NRC further commented that other countries have indicated that internal security is a national concern and IAEA security reviews are and may continue to be unacceptable to member states.

The IAEA Secretariat provided the following comments.

> "It is doubtful whether IAEA should have a role in enforcing physical security standards (or in the pursuit of material) which is generally regarded as a national police responsibility. However, requirements that IAEA's physical security recommendations be universally observed, and that reports be submitted to IAEA are desirable. Verification by IAEA of such observances might become feasible at a later date."

It should also be noted that IAEA has called for a meeting in the latter part of 1977 to consider the U.S. proposal for an international convention on physical security.

CONCLUSIONS

The administration's proposal is designed to overcome some of the problems that IAEA is having in the technical implementation of safeguards. This ongoing effort is commendable but should be part of an overall plan which would also improve other, less technical aspects of safeguards.

Merely increasing U.S. financial contributions to IAEA will not solve the safeguards difficulties. In fact, the IAEA may not be able to effectively absorb any further substantial increases in U.S. monetary and in-kind assistance.

There is a need for more direct assurances from IAEA that it does have the capability to effectively safeguard nuclear material. We recognize the need for continued confidentiality of some sensitive information but believe more information about IAEA safeguards should be forthcoming. For example, if a significant quantity of unaccounted-for material is noted by inspectors, it should be reported.

Assurance that international safeguards are effective is vital to any non-proliferation plan. Safeguards, when applied to one country's nuclear activities, should provide sufficient assurance to other countries that nuclear material is not being suspiciously lost or diverted for non-peaceful purposes.

International safeguards, without adequate physical security measures, cannot prevent nuclear terrorism or sabotage. Because stolen nuclear material may be used anywhere, effective worldwide physical security should be a major concern. The efforts of the major suppliers to require adequate physical security on their exports is a step in the right direction, but such a requirement can be interpreted differently by each supplier. A more common evaluation of worldwide physical security measures is needed.

Many countries believe any outside efforts to review the protection provided their nuclear material would be an infringement on their sovereign rights. However, we agree with the IAEA Secretariat that the short range goal should be for IAEA physical security standards to be universally observed and reports submitted to IAEA. Physical security reviews by IAEA might become feasible at a later date.

The United States must prove that it can deal effectively with domestic safeguards problems if it is to convince other nations that international safeguards can be effective. If it cannot, then international safeguards, based in large measure on the U.S. system, are prone to failure in other parts of the world. ERDA commented that the United States is trying to maximize the effectiveness of both domestic and IAEA safeguards.

RECOMMENDATIONS TO THE AGENCIES

We recommend that the Secretary of State, with the assistance of the Secretary of Energy and the Chairman, Nuclear Regulatory Commission, in concert with other member nations, should:

--Make a thorough financial analysis of the International Atomic Energy Agency to determine whether the Agency can effectively absorb increased U.S. monetary and in-kind assistance.

--Propose that IAEA establish standards for the number of inspectors needed for effective and efficient inspections and that each country accredit enough inspectors to meet those standards.

--Request that IAEA make its comprehensive report on the safeguards program available to member nations.

--Obtain, with the consent of the inspected nation, IAEA inspection reports for facilities and material supplied by the United States.

--Provide the Congress with an evaluation of the implementation of IAEA safeguards in the United States as well as the results of the inspections.

--Propose that IAEA issue periodic reports on material noted as unaccounted-for during its inspections.

RECOMMENDATIONS TO THE CONGRESS

We recommend that the Congress provide no additional special funding for International Atomic Energy Agency safeguards beyond that in the U.S.-assessed share and normal voluntary contributions without obtaining formal assurances from the executive branch that IAEA has the ability to use such monetary and in-kind assistance effectively.

The Congress should also include as two of the objectives of any nuclear non-proliferation legislation (1) improvements in the U.S. domestic safeguards (material accountability) program as an example for the international community and (2) efforts to promote a greater role for IAEA in the activities to improve global physical security of nuclear material.

NUCLEAR PROLIFERATION AND SAFEGUARDS, OTA REPORT

(Excerpt)

Chapter VIII Control of Proliferation

The first seven sections of this report described the nations or groups that might want to make weapons and how they might go about it. The materials required for such an enterprise are common, and will become more so as nuclear technology spreads. Many means of control have been developed or proposed to prevent this material from being used for military purposes. There are four general levels on which these efforts can be based. The first is to detect if a diversion has in fact taken place, through the use of safeguards measures. In the United States, the term safeguards generally encompasses physical security, since the threat (non-state adversaries) is the same for both types of protection. On the international level, safeguards and physical security are quite distinct. International safeguards are measures designed to detect and deter diversion and misuse of fissile material by governments authorized to hold such material, while physical security is designed to foil theft, sabotage, and external attacks by unauthorized groups and individuals. From a political and institutional standpoint the two problems are quite different. Supplier and recipient governments have a common interest in physical security, but by definition, national diversion does not involve such a community of interest. Safeguards assume a potentially adverse relationship between inspectors and users of nuclear material. Consequently, safeguards involve the imposition of external controls on the user state by a supplier state or regional or international agency. Primary responsibility for the application of international safeguards has been assumed by the International Atomic Energy Agency (IAEA). Euratom, an agency of the European Community, has regional safeguards responsibilities which are being coordinated with the IAEA. Neither of these agencies has the power to provide or require physical protection, or to pursue and recover stolen material. Nor do they have the authority to detect clandestine weapons facilities or purchase/theft activities. The functions they do perform are described below. Other functions can be performed by intelligence agencies (such as the CIA) as alluded to in the sections on these routes.

In our own government from 1946 to 1974, the important branches were the Atomic Energy Commission (AEC), the Department of State, and the Congressional Joint Committee on Atomic Energy. Two years ago the AEC was split into the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC). The NRC is responsible for safety rules, security safeguards, and accounting safeguards throughout this country.

The second level is to respond to a detected diversion in such a manner as to force its reversal and deter others from like actions. Neither the IAEA or Euratom have any significant authority in this area, nor has any other international institution. If sanctions are to be applied it must be done by arrangements among nations, as discussed below.

Third, nuclear systems and facilities can be limited to those that minimize opportunities for diversion. This requires cooperation among all suppliers of nuclear equipment. It consists of restricting the export of sensitive facilities (enrichment and reprocessing plants), except possibly for those operated under multinational control. The development of reactors and facilities that are inherently less vulnerable can be emphasized. Suppliers' conferences have been useful in attaining some of these ends. Multinational fuel-cycle facilities may be a promising approach for others. There appears to be very little emphasis yet on low vulnerability systems in any country and no international move to implement them.

The final level is to set a climate in which nations will not want to proliferate. This means decreasing incentives and enhancing disincentives as discussed in chapter IV. It also means weaving a network of treaties, promises, and commitments that is hard to break becuase of the moral, financial, and public appearance factors that act on modern nations. The Non-Proliferation Treaty (NPT) has been a cornerstone in this effort, binding its parties to accept IAEA safeguards on all their nuclear material and on all exports (even to nonparties).

International cooperation is the thread that binds all these objectives. None is perfect or even very effective by itself. Together the total may be greater than the sum of the parts, but only if there is a continual effort to strengthen each element. If successfully and flagrantly breached, the entire system could rapidly collapse.

The first part of this chapter describes the controls the United States places on its domestic nuclear program to protect against theft or diversion of nuclear material. The IAEA procedures for the detection of diversion of nuclear material are also discussed. The second part of this chapter analyzes the institutions and other arrangements designed to control proliferation. Appendices VIII and IX of volume II provide further detail on safeguards and on the international institutions respectively.

SAFEGUARDS TECHNOLOGY

U.S. Domestic Safeguards

In the United States, safeguards have been defined as "all measures designed to detect, deter, prevent, or respond to the unauthorized possession or use of significant quantities of nuclear materials through theft or diversion; and sabotage of nuclear facilities."[1]

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[1] WASH-1327, p. V-61 (August 1974) Draft (GESMO).

The three subsystems of the U.S. safeguards system are physical protection, material control, and material accounting. These subsystems are discussed in detail in appendix VIII of volume II.

The primary safeguard measures the United States uses to prevent or detect diversion are the physical protection and material control systems. The goal of the physical protection subsystem is to prevent access by force, stealth, or the use of false identity to nuclear material in a facility or shipment. This subsystem should prevent unauthorized removal of nuclear material and prevent sabotage. The physical protection subsystem overlaps the material control subsystem, which is designed to detect any unauthorized or suspicious activity involving nuclear material.

Examples of elements of a physical security system include armed guards, barriers, alarms, locks, portal monitors for detection of smuggled nuclear material, a central command and communication station, search procedures, and liaison with local and State police. Material control encompasses a set of procedures for access to and transfer of nuclear materials. The aim of these procedures is to prevent any two insiders, acting in collusion, from diverting nuclear material from the facility. The effectiveness of these procedures depends on the interpretation of regulations by NRC and the facility operator, and on continued surveillance and testing to ensure that the procedures are in fact being followed.

Material accounting for nuclear material is similar to accounting systems for other valuable materials, involving complete records of movement of the material and the taking of physical inventories. At present, the primary job of the material accounting subsystem is to determine, after some period of time, that the other two subsystems have been effective, or to provide information as to where and how they may have failed. Highly automated, semicontinuous measurement systems designed to provide *prompt* information that nuclear material may be missing are under development. (See "Advanced Material Accounting Systems" in this chapter.)

A history of U.S. safeguards from 1946 to the present is given in appendix VIII of volume II. Until recently, safeguards have not been a matter of high priority to government or the public. Several years ago, safeguards began to attract widespread interest and increased funds were provided. However, a sudden injection of interest and money cannot quickly make up for years of complacency.

In the United States there are three major nuclear programs and three agencies having safeguard responsibilities. The three programs are: military, nuclear power, and nuclear research. The Department of Defense provides safeguards for the nuclear weapons in its possession. The Energy Research and Development Administration (ERDA) operates production facilities for the nuclear military programs and conducts research on nuclear power and other nuclear applications. The Nuclear Regulatory Commission (NRC) is responsible for applying safeguards to both privately owned nuclear facilities and a few ERDA-owned facilities.

NRC Safeguards

This discussion focuses on NRC safeguards. The NRC safeguards can be considered in four classes. The first three are of present concern; the fourth allows time for further study. These problems are:

1. Protection of power reactors against sabotage;
2. Protection of shipments of privately owned weapons-grade material;
3. Protection of existing production facilities that possess and process weapons-grade material against theft or sabotage; and
4. Protection of future fuel facilities that would process large quantities of plutonium-containing fuel or other concentrated weapons-grade material.

The key facilities to be guarded in a domestic nuclear power program are (1) those which a non-state adversary might sabotage, or (2) those from which it might steal or embezzle nuclear material that can be used in a nuclear weapon with little or no processing.

Protection of Power Reactors Against Sabotage.—The reactor itself must be safeguarded against sabotage, but not, at present, against theft of weapons-grade material. U.S. reactors (with the one exception of the Fort St. Vrain HTGR) do not presently contain onsite material useable in nuclear explosive weapons, except for the plutonium contained in spent-fuel elements. (See discussion in chapter VII of the usefulness of spent fuel to the non-state adversary.)

The subject of reactor sabotage was judged peripheral to the topic of this study—nuclear weapons proliferation. Thus, this report has not assessed safeguards at U.S. reactors.

Shipments of Privately Owned Weapons-Grade Material.—Presently, NRC and ERDA require physical protection for shipments of strategically significant amounts of special nuclear material, i.e., more than 5 kilograms (kg) of highly enriched uranium, or 2 kg of plutonium or U^{233}. Until recently, both ERDA and privately owned materials were transported by private transport companies which met the then-existing security requirements. In 1976, ERDA decided to provide its own transportation system for its nuclear materials, including highly enriched uranium fuels for naval reactors and research reactors and plutonium fuels for the test breeder program. In consequence, all ERDA shipments of significant amounts of nuclear materials between its facilities, private contractors licensed by NRC, and ERDA and private facilities, are now protected by the ERDA system, while the relatively few shipments of *privately* owned materials are subject to NRC regulations.

ERDA and NRC transportation safeguards are described in appendix VIII of volume II. The important differences between the two systems are: (a) ERDA transport convoys maintain continuous communication with the ERDA control center in Albuquerque over a nationwide dedicated communications network (SECOM). SECOM cannot be used by NRC shipments; (b) ERDA shipments are made in specially designed tractor trailers providing protection to the drivers, resistance to penetration, and wheel locks. The transport vehicle is accompanied by escort vehicles, with which it is in constant communication. NRC requirements are less stringent.

There appear to be no serious legal, economic, or institutional reasons for NRC shippers not to employ the ERDA communications and control system. This, coupled with the use of tractor trailers (similar in performance to ERDA's) and the requirement of an accompanying escort vehicle would significantly upgrade NRC transportation security.

Protection of Existing Facilities That Possess Weapons-Grade Material.—The NRC has licensed 15 privately owned facilities (listed in volume II, appendix VIII) to process strategic quantities of highly enriched uranium or plutonium.

There is at present a controversy over whether or not safeguards at these facilities are adequate. The controversy centers on what level of threat the safeguards should meet: i.e., the debate is about the *physical security* systems.

In the spring of 1976, a joint NRC-ERDA task force investigated the safeguards systems at these facilities. The threat-levels defined for the review consisted of:

- an internal threat of one employee occupying any position, or
- an external threat comprised of three well-armed (legally obtainable weapons), well-trained individuals, including the possibilities of inside knowledge or assistance of one insider.[2]

Nearly half of the licensees were found unable to meet this total threat level and were ordered by NRC to upgrade their physical security. A number of critics, notably the National Resources Defense Council (NRDC), have claimed that the above threat level is far too low. NRDC quotes a memorandum from Carl Builder, then Director of NRC's Division of Safeguards, expressing concern that some current licensees could not meet the *lowest* threat being considered for the safeguards supplement of the *Generic Environmental Statement on Mixed-Oxide Fuels* (GESMO), which was, like the threat level postulated above, three outsiders and one insider. NRDC further efers to several studies done for NRC which spoke of maximum credible threats or credible threats in the range of 12 to 15 or 6 to 8 persons, with 2 or 3 insiders.

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[2] NUREG-0095/ERDA 77-34: Joint ERDA-NRC Task Force on Safeguards (U) Final Report, July 1976. [Unclassified Version].

The National Resources Defense Council petitioned NRC to dispatch Federal marshals as an emergency procedure to ensure security at the facilities. This petition was denied by the NRC commissioners. On January 21, 1977, the commissioners stated their intention to conduct a public rulemaking "to consider upgraded interim safeguards requirements and proposed longer term upgrading actions."

In late February 1977, NRC decided that security at these facilities should be upgraded to meet a threat of two or more insiders acting in collusion with an outside group of several adversaries armed with automatic rifles, recoilless rifles, and high explosives. Guard forces were ordered increased and required to be armed with semiautomatic rifles. Full-field background investigations were required for licensed employees who might effectively conspire to steal or divert weapons material.

This report has not assessed NRC safeguards at the facilities in question, but several general observations can be made. Of all of the attributes of the potential adversary, numbers has received the most attention. This may be because the number of possible assailants is the easiest attribute to deal with in designing a security system. The estimated number of attackers is also often considered to directly determine the required number of guards. Guards are an expensive component of security systems. Guards at Government facilities must be paid for by Government; at licensed facilities by private industry. A requirement to maintain a large guard force could shut down some facilities not able to pay the costs and remain profitable.

Appendix III of volume II summarizes a number of studies of threat size and describes the data bases of the studies.

Current research at the RAND Corporation is investigating a number of (non-nuclear) adversary actions which have been selected as analagous to potential nuclear theft or sabotage. This work shows that groups of 3 to 6 are common, that larger groups do appear, and that a group size of 12 does appear to be somewhat of an upper boundary, although there are a few cases in modern industrialized societies in which larger groups have been involved. More importantly, the RAND researchers argue that one must be extremely cautious in interpreting historical data regarding the number of attackers. The number of attackers taking part in a mission are, for the most part, what the perpetrators perceived to be necessary to accomplish the mission, and in most cases what turned out to be sufficient. In other words, the adversaries came with as many as they needed to do the job, and no more. The fact that most came with a handful of persons, 3 to 6, does not represent an upper limit on their capacity to mobilize people. The upper limit would appear to be higher.

Although the historical data are useful as a guide, an estimate of the number of attackers is inescapably a matter of judgment. Without speaking in terms of a maximum threat, the RAND studies suggest a range of anywhere from 7 or 8 to about 15 as a *prudent* estimate.

Again, although it is judgmental, military men and law enforcement officials argue that more than this number might be counterproductive. It is no coincidence that after 5,000 years of military history, the smallest operational unit of almost all armies is a squad composed of 9 to 13 men. Although an attacking force could be composed of several squads, it should be recognized that to assemble even 10 or 12 attackers would stretch to the limit the capacity of most known violent political extremist groups in this country. Moreover, although no one has attempted to determine precisely how many persons must be in conspiracy to commit a serious crime before it is no longer a secret, the probability of discovery must increase rapidly in the higher ranges. The fear of leaks appears to be a principal consideration and constraint in assembling the personnel for a task-force crime.

The number of attackers is not the only parameter to consider in determining the adequacy of physical security. Another factor to consider is armament. Here the potential adversaries seem to have the edge. Civilian guard forces are armed with pistols, shotguns, and in some cases, semiautomatic rifles. (The recent NRC upgrading calls for guards armed with semiautomatic rifles. Guards at ERDA facilities may be armed with automatic weapons and at some facilities may also have armored cars.) NRC officials concede that attackers may be armed with automatic weapons, hand grenades, and possibly even antitank weapons.

Another, and a most important parameter, is tactics. Armed robbers seldom assault their target. They employ stealth, deception, diversion, and other techniques to gain access. Often they are inside or close upon the guards before displaying arms and revealing their intentions. Deception often proves to be successful where assault would probably fail.

A fourth set of parameters involves the size and location of the facilities themselves, and the amount, form, and location of the nuclear material they possess. The number of guards, indeed the adequacy of the physical security system as a whole, is a judgment that can only be made by an examination of each specific site. The approach to be taken should be to design an entire physical security system to protect a specific facility against all conceivable actions—burglary, armed robbery, embezzlement, sabotage, armed assault, standoff attacks—rather than to pick a number of attackers and let an equation determine the number of guards. Once this is done, a team composed of physical security experts and nuclear technology experts should jointly assess the system probing for weaknesses and trying to design successful attacks on the system (i.e., black-hatting evaluation should take place).

This is the approach being taken by ERDA and NRC in their safeguards research programs, discussed in more detail in the section on "Domestic Safeguards Research and Development" later in this chapter. The safeguards system concepts now being developed aim to integrate safeguards and physical security into the design of new facilities, and hold the promise of making them more easily defensible against both outside attack and inside embezzlement. The point to emphasize here is that physical security can and should eventually be upgraded in more basic, varied, and imaginative ways than by simply increasing the numbers of guards and the power of their armament.

For example, it should be recognized that there could be an alternative to relying on onsite guard forces to overcome armed adversary attack. A crucial question, which deserves serious review, is the extent to which safeguard systems can be designed to *delay* attacking adversaries sufficiently so that the burden of engagement and arrest falls on offsite response forces instead of on onsite guards.

The preceding discussion on numbers of attackers and guards leads to another issue involving guards at nuclear facilities. At present, unless they are deputized by a Government agency, guards at nuclear facilities have only limited civilian-arrest powers. Moreover, the powers of such guards, particularly with respect to the use of deadly force and permissible behavior in hot pursuit, vary from State to State (some licensees have facilities in more than one State). Guards who overstep State laws, even to protect special nuclear material, can face lawsuits. Although unauthorized possession of special nuclear material is a Federal crime (Sec. 42 U.S.C. 2271(b) and 2272), it is not clear if this crime, by itself, is a dangerous felony. The use of deadly force is justified only to prevent a dangerous felony.

The entire subject of the powers and status of guard forces at privately owned nuclear facilities should be reexamined. The subject of a Federal security force to protect weapons material should be reopened, particularly in view of the increased threat levels licensees are being required to meet.

In addition, there are indications that safeguard threats to private nuclear facilities are coming to be regarded as threats to national security, without being explicitly defined as such. Should sabotage of a nuclear power reactor or detonation of a nuclear explosive by terrorists be regarded as having national security significance? Would sabotage of a large dam or of a liquid-natural-gas tanker, which would cause comparable damage, be a threat to national security? So far, these questions have not been explicitly considered.

One measure that apparently hinges on the question of national security significance is the requirement of clearances for employees of nuclear facilities. NRC and ERDA have maintained in the past that only a few key employees of private nuclear facilities would (or should) be cleared. The purpose of this clearance would be to provide added assurance that managers and guards would not engage in conspiracies to steal nuclear material or sabotage nuclear facilities. The legal basis for such a clearance requirement is an amendment to an appropriation bill (Public Law 93-377), which authorized the Atomic Energy Commission (AEC) to require clearance for licensee personnel if deemed necessary for national security. In light of this wording, NRC seems to have implicitly decided that safeguarding nuclear facilities is essential to national security; that is, it seems possible that the enabling statute which authorizes security clearance for national security reasons might not provide the authorization necessary to clear nuclear employees who may not be involved in national security.

By the year 2000, according to the Draft Societal Impact Chapter of GESMO, the number of people employed in mixed-oxide fuel cycle facilities and requiring security clearances would be in the range of 13,000 to 20,000. In addition, NRC has recently announced a proposed rule to require that 6,000 employees of 63 nuclear reactors be cleared. This program is aimed at protecting against reactor sabotage. This represents a substantially larger number of employees than those "few hundred" thought to be affected when the appropriation bill mentioned above authorized the AEC to implement a clearance program for private licensees.

The question of national security significance needs to be clarified. Moreover, if protection of nuclear facilities against domestic threats is defined as necessary for national security, the policy of using private guard forces becomes extremely questionable.

Protection of Future Fuel-Cycle Facilities.—The preceding discussion of physical security at nuclear facilities has highlighted certain tasks that must precede effective evaluation and implementation of safeguards. These tasks include the determination of a reasonable estimate of the size of a potential attacking force, the inclusion of other attacker attributes in the design of physical security systems for a specific facility, the clarification and standardization of guard powers, and the decision on whether theft from, or sabotage of, a nuclear facility constitutes a threat to national security.

These tasks are important for both existing and future facilities if plutonium reprocessing goes forward.

It is not clear at this time if or when NRC will license plutonium processing facilities. The only such plant which could start operations within the next few years is the Allied-General spent-fuel reprocessing plant, which has been built at Barnwell, S.C. Other facilities to produce plutonium oxide or to fabricate plutonium for breeder reactors exist only on paper and are 5 to 10 years from completion. In the meantime, the ERDA safeguards R&D program is working to develop substantially improved safeguard techniques to meet the problems posed by large-scale plutonium processing and fabrication facilities. Several techniques are discussed below under the heading "Domestic Safeguards Research and Development."

Domestic Safeguards Research and Development

Both NRC and ERDA have safeguards R&D programs. ERDA has the responsibility for developing safeguards for the new energy systems it develops, and also to ensure that the safeguards for its military and research programs will meet future safeguard goals. On the other hand, the Energy Reorganization Act of 1974 assigned NRC the responsibility for confirmatory research. This has been interpreted so far to mean that ERDA would support the bulk of hardware research, technology development, and demonstration and testing of safeguards systems in actual facilities, while NRC has put emphasis on systems studies, on the development of analytical techniques, and on programs to help it to (1) define safeguard requirements for the facilities that it regulates, and (2) assess not only compliance of these licensees but also the effectiveness of its role in protecting and advancing the interests of the U.S. public.

The most important subjects for study, which both NRC and ERDA are emphasizing, are the methods of assessing and evaluating safeguard systems and subsystems, and of how to make cost-benefit analyses. Both tasks, especially the latter, are very difficult when the threats are hypothetical, the systems remain untested because there have been no significant incidents so far, and the consequences range from zero to catastrophic.

Appendix VIII of volume II describes the principal elements of U.S. domestic safeguards research. The following section discusses and, to the extent possible at this time, evaluates several specific technical safeguards concepts of particular prominence.

Massive Spiking

Massive spiking is the addition of lethal amounts of radioactive material to fresh reactor fuel. The purpose of massive spiking is to protect fresh fuel containing highly enriched uranium or plutonium against theft by nonstate adversaries. The idea has a long history and several studies have recently been done, the most complete of which was a part of the 1975 NRC Special Safeguards Study. It considered several possible methods to achieve massive spiking, and also the possible attachments of intensely radioactive cobalt—60 rods to fresh-fuel assemblies.

The NRC study concluded that massive spiking of fresh fuel would not constitute an insuperable obstacle to an adversary who was competent (1) to separate plutonium from uranium in mixed-oxide form, and (2) to design and fabricate an effective terrorist nuclear explosive.

On the other hand, such spiking would increase the cost of fuel fabrication and transportation by a large factor, expose nuclear facility employees to increased radiation, and substantially increase the risk to the public due to accidents or acts of sabotage.

Attaching cobalt-60 sources to fresh fuel in shipment would place one more obstacle in the way of the diverter, but not an insurmountable one. It would increase transportation costs but more importantly create problems both in loading and unloading and in the risk of accidental exposure.

Massive spiking is not cost-effective when compared to massive containment and stringent physical security for domestic safeguards use. It would not be useful at all in restraint of national proliferation.

Light Spiking

Light spiking is the addition of low levels of radioactive material to fissile material to afford easy detection. This concept was also investigated in the NRC Special Safeguards Study. All three fissile isotopes—U^{235}, U^{233}, and plutonium—are naturally radioactive. The important question is how difficult it would be for an adversary to shield significant amounts of any of these isotopes and pass radiation monitors without being detected.

The NRC study concluded that: (1) gram amounts of highly enriched uranium in easily carried shielded containers can probably be removed without detection; (2) portal monitors equipped with both gamma-ray and neutron detectors should detect attempts to remove as little as one to several grams of plutonium in portable shielded containers; (3) existing portal monitors should effectively detect small quantities of U^{233} because of the highly penetrating (2.6 MeV) gamma-rays associated with unavoidable trace impurities of U^{232}.

The study recommended that the subject of low-level spiking for highly enriched uranium be investigated further, and that an experimental program be undertaken to design and test gamma-ray and neutron portal monitors for plutonium of various isotopic compositions.

Evidently, no further studies or experiments were conducted by NRC or ERDA. It would therefore be useful if: (1) ERDA institutes a design, test, and evaluation program for portal monitors in actual production facility environments (radiation backgrounds directly affect monitor sensitivity), and (2) NRC or ERDA initiate a study to assess costs and benefits which might derive from low-level spiking of highly enriched uranium. It should be noted that the large amounts of highly enriched uranium in military and naval programs are presently the most attractive targets for an adversary who wants material to use in a nuclear explosive.

Spiking is unlikely to be used except for domestic safeguards, but the subject of radiation monitors for surveillance of nuclear facilities is of considerable interest to the IAEA.

Denaturing of Plutonium

The concept of denaturing Pu^{239} with Pu^{240} or some other isotope of plutonium also has a long history. It has long been believed that a high content of Pu^{240}, because of its high spontaneous fission rate, renders plutonium unsuitable for use in a nuclear weapon. This is not true. A high content of Pu^{240} *is* a complication. Given a free choice, a designer would prefer low Pu^{240} material, but *all* plutonium isotopes can be used directly in nuclear explosives. (See chapter VI.)

Storage and Transport of Plutonium in Dilute Mixed-Oxide Form

Plutonium oxide stored and transported in a mixture containing large amounts of uranium oxide (i.e., dilute mixed-oxide form) would present a significant (but *not* insurmountable) obstacle to the non-state adversary. This technique would be a much less-effective deterrent against national proliferation than against the non-state adversary. The dilute mixed-oxide material might be produced in the following ways:

(a) Plutonium would not be separated at all from uranium at the reprocessing plant (coprecipitation)

(b) Plutonium would be incompletely separated from uranium at the reprocessing plant (partial coprecipitation)

In alternate (a), the concentration of plutonium in uranium would be approximately 1 percent. The machinery for separating plutonium and uranium would not exist, so plutonium could never appear in concentrated form in the fuel cycle. However, the increased costs of both a larger nitrate-to-oxide conversion facility, and a larger plutonium-uranium mixed-oxide fuel fabrication facility, plus the necessity for over-enriching additional uranium, could more than outweigh savings in the solvent extraction process and in eliminating conversion of recovered uranium to UF_6. If so, this option would not be economically attractive compared to (b) with more stringent safeguards. ERDA plans to consider option (a), at least in the preliminary stages of its Alternate Fuel Cycle Study. (See chapter VII "Diversion From Commercial Power Systems.")

Alternate (b) appears to provide significant improvement in safeguards without undue economic penalties. In effect, it moves one processing step from the fuel-fabrication plant to the reprocessing plant.

The major contribution of scheme (b) is elimination of transport of concentrated plutonium. A potential non-state embezzler or national diverter could still tinker with the separation system at the reprocessing plant to produce pure plutonium. Materials accounting in a large plant could not provide timely detection of the removal of 10 kg of pure plutonium, thus the physical security and material control subsystems (or the containment and surveillance systems in the case of IAEA safeguards) would be crucial.

As far as this report has determined, the only study of the deterrent effect of diluting plutonium with uranium was done as part of the NRC Special Safeguards Study. The study investigated the effort required by a non-state adversary group to separate plutonium from uranium. It concluded that an ion-exchange operation, operated in a 10 kg batch mode with 5-percent-plutonium content, would require $5,000 in chemical costs alone. The time per batch was not explicitly stated, but analysis of what is presented suggests 40 to 80 hours processing time per batch, or 30 to 60 days of round-the-clock operation to obtain 10 kg of plutonium. The process as described is clearly not a laboratory operation; it is a small pilot-plant operation, and as such requires the supervision of someone with *practical* experience in chemical engineering or larger-than-laboratory scale chemistry. The time required for the operation, during which the adversaries are immobile, significantly enhances their chances of being discovered.

It is not clear whether any additional work on this subject has been done. It would be valuable to have a clearer idea of the actual time-delay granted by this technique. Although a month or two may be too long, at least several weeks sounds extremely plausible. It would also be useful to examine what new search and recovery techniques could take advantage of the fact that the adversaries would be carrying on a pilot-plant scale chemical operation.

The following proposal for colocating reprocessing and fuel fabrication facilities is closely related (in its potential effect on safeguards) to the above proposal for diluting plutonium oxide with large amounts of uranium oxide.

Colocation of Reprocessing Plant and Fuel Fabrication Plant

If reprocessing plants were sited adjacent to fuel fabrication plants, the transportation of plutonium in concentrated form would be eliminated. However, although the NRC Nuclear Energy Site Survey-1975 (NUREG-001) concluded that ". . . . colocation might have a beneficial effect on safeguards effectiveness; however transportation safeguards considerations do not preclude dispersed siting," all the advantages and disadvantages of colocation have not yet been assessed in any systematic way. This question cannot be separated from the previous question—that of complete or partial coprecipitation of plutonium oxide and uranium oxide at the reprocessing plant. If some form of coprecipitation is used, then the added advantage of colocation would seem to be small.

Advanced Material Accounting Systems

There are unavoidable limitations on material accountancy because of statistical measurement errors. These errors will translate into an inability to detect diversion of significant quantities of weapons material in future large commercial facilities unless the sensitivity of material accountancy can be significantly improved.

No substantial and economical improvement in the sensitivity of materials accountancy can be expected unless real-time material control can be achieved. Two such systems are being developed: DYMAC at Los Alamos Scientific Laboratories (LASL) and RETIMAC by NRC. (See appendix VIII of volume II for a description of these systems.) These two R&D programs have the same goal: to provide continuous or nearly continuous measurements of all materials being stored, transferred, or processed.

The LASL safeguards group is developing instrumentation and online computer systems for DYMAC. This system is being implemented at LASL in three phases. In phase I, the present LASL plutonium processing facility is being used as a test bed for component development and operator training. Phase II is the design and installation of a DYMAC system for the new plutonium processing facility (TA-55) presently under construction at LASL. This is a small facility with a typical throughput of tens of kilograms per month of plutonium. It does not handle spent fuel. Installation of DYMAC/TA-55 is scheduled for June 1978. Phase III is a program to evaluate the performance of DYMAC at the TA-55 facility.

Operation of DYMAC/TA-55 in the new LASL plutonium processing facility is intended to investigate:

- the reliability and operational feasibility of online nondestructive analysis instrumentation in a production environment,
- the timeliness and sensitivity to missing nuclear material that can be achieved,
- the accuracy and efficiency of data collection that can be achieved,

- the operation of common data base management, and
- the capability for production control, quality assurance, and financial management.

Another task is to design on paper and evaluate the cost effectiveness of such systems for future commercial facilities. The most useful of these studies has been done by LASL and Sandia as part of a project to develop an integrated safeguards system for a mixed-oxide fuel fabrication facility. The report gave estimates of costs and sensitivities for the real-time measurement and analysis system.

LASL and Sandia based their designs on a mixed uranium-plutonium oxide fuel fabrication plant planned by Westinghouse for construction at Anderson, S.C. (Throughput 8000 kg/year of plutonium.) They contacted Westinghouse for assistance in defining plant parameters and providing cost estimates. Although this is a paper study, plant data are realistic and the online measurement and computer systems are conventional or state-of-the-art.

The report states that capital safeguards costs for this system are less than 5 percent of the total plant cost and the total safeguards staff (excluding guards) is about 8 percent of the total staff of 300. At a false-alarm rate of 0.1 percent, a single theft of the order of 0.1 to 0.2 kg of plutonium could be detected with a 50 percent probability. With a 16 percent false-alarm rate, a dribble theft of approximately 1 kg over 1 month could be detected with an 85 percent probability of detection. These results should be compared with present NRC requirements for a fuel fabrication facility which are: a 50 percent probability of detection of removal of 0.5 percent of throughput with a material balance every 2 months and a false-alarm rate of 2.5 percent. For the case above, this corresponds to a 50-50 chance of diverting 7 kg of plutonium in 2 months, without being detected by the materials accounting system. (Note that this does *not* mean a 50-50 chance of diverting 42 kg of plutonium per year.)

Although considerable development work and in-plant demonstration is required, before the effectiveness and costs of real-time material control can be reliably assessed, the studies indicate that improvements made using DYMAC will be greater for fuel fabrication facilities than for spent-fuel reprocessing plants. DYMAC is batch-oriented, as is the operation of a fuel fabrication plant, whereas a reprocessing plant is a continuous operation.

The R&D Office of the NRC has been supporting work at Lawrence Livermore Laboratory (LLL) on systems studies of material control and accounting techniques, which include automated online measurements systems for nuclear production facilities (RETIMAC). These are purely software studies, and are not advanced enough to give sensitivities or costs.

One thing that *is* clear is that even real-time, online materials accountancy systems cannot do the entire safeguards job. Physical security, containment, and surveillance will still have crucial roles to play in any effective safeguards system.

Research on Physical Security Systems

Work on physical security systems for new facilities is being performed by Sandia Laboratories under contract to ERDA. The approach is to design for specific nuclear facilities, either existing ones such as the Allied General reprocessing facility, or specific engineered designs such as the Westinghouse fuel fabrication plant proposed for construction at Anderson, S.C.

On the assumption that credible threat characteristics may change in the future, the researchers postulate a spectrum of internal and external threats, and various combinations of the two. Combinations of barriers, alarms, and guards are chosen to provide multiple impediments to an intruder, or to authorized insiders attempting to perform unauthorized acts. A spectrum of divisionary scenarios, including emergency situations, are considered. The physical protection design is coordinated with the Los Alamos design of fully automated online nuclear material measurement and control of all nuclear materials in the facility. Capital and operating costs for a given system configuration are determined with assistance from the designers of the particular facility. (Compare with the preceding section on "Materials Accountancy.")

Sandia and Brookhaven have developed computer-based models to assess the comparative effectiveness of alternative combinations of safeguards elements to protect nuclear materials against postulated overt attacks on the facility with or without the aid of one or two insiders. Sandia is also in the process of developing models for assessing the safeguards systems against covert diversion attempts by a trusted employee or by several employees in collusion. This is based on the National Bureau of Standards analytical method called "Diversion Path Analysis." The overt-attack model is presently in use. The covert-diversion model is still in the early developmental stage. The assessment experts emphasize that their analytical tools give qualitative rather than quantitative assessments of effectiveness.

ERDA safeguards system designers believe that the strategy and performance of both adversary and defender personnel are very difficult to predict in any satisfactory manner. Hence, special attention is paid to physical barriers and devices which will *delay* the adversary, whatever his skill and dedication, without requiring heroic behavior by the onsite guard force. Another aim is to design a safeguards system that will be adaptable to changing design threats with economically acceptable modifications in plant equipment or changes in the size of the guard force.

The most effective safeguards system will be one in which the various safeguard elements are balanced against each other and are integrated into the design of the facility. At this time, it appears to be at least as important to develop a methodology for evaluating the effectiveness of a safeguards system as it does to work on the development of equipment and computerized controls. In order for safeguards assessments to give useful results, reliable input data on the individual elements of the safeguards system is necessary. It is also important, therefore, to continue the experimental program to provide better information on the penetration resistance of barriers, reliability of alarms, and efficacy and safety of techniques, such as foams and reactive sensors that *delay* and *confuse* the adversary.

The object of designing a safeguards system to delay attacking adversaries has been described by de Montmollin and Walton:

> "The effect on the design against forcible theft is heavy reliance on passive barriers, the restriction of material accessibility, and protected defensive positions for guards. It is not necessary for the safeguards system to capture or kill adversaries; it is only necessary that control of the material be maintained. The system should be designed to withstand a protracted siege, and the sequence of actions necessary for an adversary to gain ultimate control of the materials should be attacked at many points. Delay should be exploited, and the uncertainty of success as perceived by the adversary should be enhanced wherever possible. Increased delay of the adversaries will correspondingly increase their probability of failure. Given sufficient delay, police support will be ultimately decisive; first, by sealing off the general area to maintain contact as adversaries attempt to break out, and eventually to overcome them. The mission of the safeguards systems must be to provide decisive delay rather than to overcome adversaries in a direct, armed confrontation."[3]

Interaction of U.S. Research and IAEA Requirements and Research

The ERDA safeguards systems development, and complementary NRC work on developing methodologies for safeguards systems assessments, hold forth a good deal of promise for both U.S. and international safeguards. ERDA is aiming for a 1980–82 demonstration of a integrated safeguards system for IAEA safeguards. A discussion of IAEA research programs, and U.S. and foreign research related to IAEA needs is given in appendix VIII of volume II.

Long-Term Safeguards Effectiveness

A subject which is of concern to some in NRC and ERDA, and which is receiving some preliminary attention, is the question of how safeguards effectiveness can be maintained during long periods of quiet. The safeguards system, as described early in this chapter, is designed to deter, detect, prevent, and respond. A safeguards system will effectively *deter* only if it is perceived as being able to very effectively detect, prevent, and respond. Functions must be exercised to remain effective, and if the object is to never give the safeguards system, and the people who run it, *real* exercise, then sufficiently challenging substitutes must be designed to maintain the quality of the safeguards system and attract good people to run it.

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[3] J.M. de Montmollin and R.B. Walton, *The Design of Integrated Safeguards Systems for Nuclear Facilities*, Nuclear Materials Management Vol V, No. III, p 317 (Fall 1976).

Physical Security Outside the United States

Primary responsibility for the application of international safeguards has been assumed by the International Atomic Energy Agency (IAEA). Euratom, an agency of the European community, has regional safeguards responsibilities which are being coordinated with IAEA. Neither of these agencies has the power to provide or require physical protection, or to pursue and recover stolen material; nor do they have the authority to detect clandestine weapons facilities or purchase/theft activities. As stressed in the introduction, international safeguards are aimed at detection of diversion by a nation from its own facilities. Physical security of the facilities is the responsibility of the nation.

IAEA does advise on physical security, and has published a discussion of physical security procedures in an IAEA manual, INFCIRC/225. In a brief discussion in the IAEA Bulletin of possible future IAEA actions on physical security, IAEA envisages its role as advising, organizing training courses and conferences, and acting as a clearinghouse for information.

The United States has also tried to encourage greater physical security on nuclear facilities worldwide, as it recognizes that nuclear material obtained in one nation may well be used in another nation. In a Presidential message dated May 1975, it is stated that the United States has adopted a policy of no longer issuing licenses for the export or retransfer of more than 5 kg of highly enriched uranium, or 2 kg of plutonium or U^{233}*, unless the government of the recipient country "has an established system of physical security measures acceptable to the United States." This report is unaware of any detailed standards of acceptability beyond a statement that they should be "comparable to those imposed domestically."

To implement this policy, physical-security review teams were dispatched by ERDA to 18 countries in 1975–76. Visits to an additional 21 nations were planned for 1976. ERDA stated that by the end of 1976, "the United States will have made reviews of the physical-security measures of all major recipients of strategic quantities of U.S. nuclear materials and intends to cover all nations with whom it has Agreements for Cooperation, as well as other nations that might receive trigger quantities through the U.S.–IAEA Agreement." This report has not assessed physical security in other countries, nor has it been able to assess the ERDA review of foreign physical security, because ERDA has classified its review citing the following reasons: ". . .states continue to keep their specific physical-security measures classified and/or under proprietary restrictions. The results of the U.S. visits are therefore classified, at the request of the nations involved, and the United States cannot divulge results of the review. Furthermore, the laws and regulations of the various recipient nations as well as the factors peculiar to each recipient nation make it difficult to present even general observations." (Some additional material is presented in volume II, appendix VIII.)

IAEA Safeguards

The Statute of IAEA states that the objective of Agency safeguards is to assure, so far as it is able, that the nuclear assistance provided by it, or at its request, or under its supervision or control, is not used in such a way as to further any military purpose. As a result, IAEA safeguards differ in one vital respect from those of U.S. domestic safeguards. Domestic safeguards are concerned with the non-state adversary. International safeguards (i.e., IAEA and Euratom safeguards) focus on the detection of national diversion.

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*These respective amounts of highly enriched uranium, plutonium, and U^{233} are sometimes called "trigger quantities" because they are the amounts that will set safeguards into effect.

The word safeguards is generally understood to be a collective term comprising those measures designed to guard against the diversion of nuclear material from uses permitted by law or treaty, and to give timely indication of possible diversion or credible assurance that no diversion has occurred. The difference in objectives between U.S. domestic safeguards and international safeguards is reflected in the different measures encompassed in the word "safeguards." As discussed in the preceding section, U.S. domestic safeguards include physical security, material control, and material accounting. For IAEA, the use of materials accountancy is considered to be the safeguards measure of fundamental importance, with containment and surveillance at present considered only as complementary measures. The following definitions for these three measures have been derived from the IAEA Safeguards Technical Manual.

Material Accountancy.—Those safeguard measures which provide the essential knowledge on the identity, composition, quantity, and location of nuclear material. The basic source of data for the Agency's accountancy system is the facility operator's measurement system, records, and reports, and the State's system of accountancy for, and control of, all nuclear material subject to safeguards. For each material-balance area within a State, the facility operator must record, and the State report, the initial inventories of nuclear material and subsequent inventory changes to IAEA. Periodically, the operator's book inventory is compared with a physical inventory taken by the operator and independently verified by an Agency inspector.

Containment.—A safeguards measure which uses physical barriers to restrict or control access to, or movement of, nuclear material. Examples include process tanks and piping, transport casks, building walls, and fences.

Plant operators use containment primarily to provide physical protection of nuclear material, for reasons of health, safety, and/or operational necessity. If safeguards requirements are included in the earliest planning phases, containment can significantly enhance the effectiveness of safeguards. Failure to do so may result in an inherently unsafeguardable nuclear facility.

Surveillance.—A safeguards measure which uses instrument or human observation to detect access to, or confirm movement of, nuclear material.

Surveillance devices and instruments are used 1) during the absence of an inspector to indicate that access to or movement of nuclear material has not compromised the integrity of prior measurements made by the IAEA, and 2) to provide the inspector with a continuity of knowledge of specific inventories and material flows at key points in the fuel cycle. Surveillance devices include cameras, television, seals, and radiation monitors.

The Evolving Role of Containment and Surveillance in IAEA Safeguards

Nuclear material accountancy has continued to be the safeguards measure of fundamental importance in the implementation of IAEA safeguards procedures. The role of containment and surveillance, however, has evolved at a relatively rapid pace within the last few years and is now assuming greater significance. It is now generally accepted that there are unavoidable limitations on material accountancy because of measurement errors. For nuclear facilities with very large throughputs, cumulative measurement errors on nuclear material will introduce uncertainties in the material balance which exceed by several times the IAEA's own limits on significant quantities of diverted plutonium or uranium which it must detect. The dictum "what one cannot measure one must watch" underscores the urgent necessity for fully operational, reliable, tamper-resistant surveillance equipment.

In addition, renewed emphasis is being placed on the NPT objective of *timely* detection. Material accountancy, with its dependence on independent verification of physical inventories and material flows, is confronted, as above, with an exceedingly difficult problem. For manpower as well as economic reasons connected with facility downtime, physical inventories may be limited to one per year in some facilities, and possibly not more frequently than four per year in the largest facilities. Under the IAEA's own requirements for timely detection, the deterrent value of a material balance may be seriously degraded. New surveillance equipment which is just now being designed may be able to meet many of the Agency's requirements for timeliness and holds forth the promise of eventually being able to provide IAEA headquarters in Vienna with real-time surveillance.

Initially, self-monitoring surveillance devices will require frequent communication between the facility operator and/or the host government and IAEA headquarters in Vienna. Within a period of 3 to 5 years, however, certain of the Agency's surveillance devices may be able to provide encrypted real-time status reports, first to IAEA regional safeguards offices and finally to the Vienna headquarters. This capability will place exceptionally stringent requirements on the long-term reliability of equipment and on the necessity for a very low false-alarm rate. The consequences of even a small number of false alarms would be so counterproductive that it seems probable that, like the space program, IAEA's equipment will be designed to meet a zero defects requirement and will be correspondingly expensive.

There have been substantial increases in money and manpower, both in the United States and within the IAEA, to develop surveillance equipment. In order to implement the increases in funding which Congress authorized under the Gifts-in-Kind Program to strengthen IAEA safeguards, ERDA has established an International Safeguards Project Office at Brookhaven National Laboratory. The draft program plan for Technical Assistance to IAEA Safeguards, Task E, Assistance for Containment and Surveillance, includes 22 separate projects. For FY 77, approximately $990,000 has been allocated to fund these projects. Funding by the United States, which is scheduled to continue over a period of 5 years, the increased support within the IAEA for surveillance equipment, and the greater willingness on the part of the nuclear suppliers to support improved measures for physical security and safeguards research in general, all should provide the Agency with reliable and effective surveillance equipment within the next few years.

Effectiveness of IAEA Safeguards for Power Reactors

On December 21, 1975, the IAEA had 43 nuclear power stations under safeguards, 10 of which were onload* refueled reactors of the CANDU or Magnox type. Most of the remainder were light water reactors (LWRs). (See annex L to appendix IX of volume II.) The Agency has fully developed model Facility Attachments and Safeguards Implementation Procedures (SIPs) for both classes of power reactors, including an analysis of potential diversion paths and possible means of countering diversion strategies. Evaluating the effectiveness of the Agency's safeguards on power reactors is rendered difficult because information about critical IAEA procedures and policies are either not available outside the Agency or are classified by the Agency as Safeguards Confidential. For example, no information is available on the Agency's site-specific diversion analyses, the allocation of its inspection effort, the reliability and performance of its surveillance and nondestructive analysis (NDA) equipment (much of which is in the early stages of development), the effectiveness of the different State Systems of Accounting and Control and, in a few instances, the inclusion of special conditions in the Safeguards Agreements with those states that restrict the nationality of acceptable inspectors or the normal use of safeguards equipment and procedures. It is hoped that in at least some of these areas the Director General's proposed Special Safeguards Implementation Report to the Board of Governors will remedy these shortcomings. This report is believed due in September 1977, after several delays totalling over a year in extent.

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*I.e., reactors that are refueled without being shut down. See chapter VII "Diversion from Commercial Power Systems," and appendix V of volume II.

Of all the types of nuclear facilities on which the IAEA must apply safeguards, the light-water power reactor (LWR) presents the fewest problems. Safeguards on these facilities are based on an item accountability of fuel elements, a procedure which in principle is free of measurement error. Light-water reactor fuel is relatively large in size and involves a relatively small number of fuel elements in either the core or storage pond. The reactor is usually refueled only once a year; the remainder of the time the reactor vessel is closed and may be sealed by the Agency. The fresh fuel, containing low-enriched uranium, is expensive to fabricate, and tight fuel specifications at the fabrication plant mean that the amount and enrichment of the uranium in the fuel is known within the narrowest limit of any point in the fuel cycle. The intense radioactivity of the spent fuel severely limits the diversion possibilities. Even under INFCIRC/153 (the document issued in 1971 to govern NPT safeguards arrangements), the Agency is permitted adequate inspection effort for effective safeguards for this type of facility. Finally, secure surveillance equipment (such as cameras) is available, although a fair amount of development and testing remains to be done in order to assemble a fully reliable system. Nondestructive analysis techniques required to minimize the threats of fuel substitution have been demonstrated, but have not been routinely applied.

The Agency has the knowledge both in principle and in practice to provide effective safeguards on LWRs and implementation is proceeding.

The safeguarding of onload refueled reactors, such as the CANDU, is substantially more difficult. Nuclear fuel for such reactors is small in size, while the number of fuel elements in the core and in either the fresh or spent-fuel storage is very large. The onload refueling feature and the possible use of unsafeguarded natural uranium in the fuel greatly expand both possible diversion scenarios and the IAEA's task of devising and implementing effective countermeasures. Since 1968, the IAEA, Canada, and the United States have been engaged in joint R&D programs specifically directed at surveillance and containment problems of CANDU reactors. More recently, the Canadians significantly increased the level of effort of their R&D programs.

Sufficient information is not available at this point to evaluate the effectiveness of the new surveillance instrumentation in combination with the traditional review of the power stations records and reports. If the IAEA concludes at the end of its testing that credible and effective safeguards procedures for onload reactors cannot be achieved, it may request, and the States probably will grant it, the right to station inspectors at such facilities on a continuous basis. Such a move would greatly increase IAEA costs and workload.

IAEA Safeguards for Enrichment Plants (Comparison of Domestic and International Safeguarding Problems)

To date, the IAEA has not safeguarded any type of enrichment facility, including pilot plants. However, it may have to undertake such a task in the near future as a result of its recent agreements with both Euratom and Japan. The proposed safeguards procedures for enrichment plants, contained in the IAEA Safeguards Technical Manual, are currently being revised and have not yet been officially released or published. Enrichment plants are not specifically covered in either of the two IAEA books of regulations (INFCIRC/66/Rev.2 or INFCIRC/153), except for one provision in the latter which states that a small plant producing uranium enriched to less than 5 percent in U^{235} need not be subject to continuous inspection.

In view of this lack of experience, and the preliminary nature of plans for safeguarding enrichment plants, only a very limited assessment of IAEA safeguard procedures can be made at this time. However, a few general statements about the difficulties in safeguarding enrichment plants and a few crucial points can be made.

An enrichment plant is the only nuclear facility besides a reprocessing plant that is capable of generating separated weapons material. However, a significant difference exists in that a reprocessing plant is designed to routinely handle material suitable for use in weapons (i.e., separated plutonium) either directly or after a simple chemical step. A commercial enrichment plant normally produces only 3 percent to 4 percent enriched uranium, which is impossible to use in nuclear-fission weapons without further enrichment. Therefore, the output of an enrichment plant is of use to the non-state adversary only if a criminal black market in low-enriched uranium develops. Portions of an enrichment plant can be reconfigured to produce highly enriched uranium. This is a credible scheme for a national diverter, but a scenario in which management and workers of a U.S. enrichment plant conspire to produce highly enriched uranium is not credible. Moreover, such a proceeding could not be kept secret from NRC inspectors who have the right of unlimited and unannounced access.

The case is different for IAEA inspection of enrichment plants. At present, IAEA inspectors are not permitted access to the cascade area of an enrichment plant (i.e., the portion of the enrichment plant where the actual enrichment takes place). Inspection techniques that are presently proposed for enrichment plants treat the cascade area as a black box with a number of inputs (e.g., people, uranium feed, and new equipment) and a number of outputs (e.g., people, low-enriched uranium, and old equipment). If a reconfiguration of a portion of the plant to produce a small highly enriched uranium loop occurred, IAEA would have to deduce its existence from input and output measurements. In the first place, materials accountancy in a large plant is not accurate enough to provide assurance that a significant diversion has not taken place. More important, new equipment is an undeclared path; IAEA is not permitted to monitor new equipment going into the plant. This path could be a route for clandestine feed for a small highly enriched uranium production loop.

For input-output monitoring to be effective, *all* streams need to be monitored. Physical inventory and surveillance methods need to complement continuous input-output monitoring. Other complementary inspection techniques would include enrichment monitoring (particularly checking tails enrichment) and the use of the isotope ratio technique to check the ratio of U^{235} and U^{234} in the product and tails.

These inspection techniques are still in the developmental stage and have not been applied in an integrated way to an enrichment plant.

Allowing inspectors access to the cascade area upon demand would greatly enhance the effectiveness and credibility of the inspection. Inspection accessibility to the cascade area would certainly not *ensure* that the plumbing changes required for a highly enriched uranium loop would be detected in the maze of cascade area piping. However, it would most likely act as a significant deterrent to any country wishing to conduct a covert operation. In addition, undeclared feed, product, or tails takeoff would also have a higher probability of detection.

There are two reasons given for restricting inspector access. The first, and probably the reason preceived as the most important, is that of protecting commercial secrets. The second is to prevent the dissemination of enrichment plant technology via the inspectors, i.e., to make nuclear proliferation less likely. This reason creates an interesting situation where, in the name of nonproliferation, inspectors are denied access to an area to which, in the cause of nonproliferation, they should have access.

IAEA Safeguards for Reprocessing Plants—Comparison With Domestic Safeguards

The eventual effective safeguarding of a large reprocessing plant presents the greatest technological uncertainty of all safeguarding problems facing the IAEA, because of the complexity of the operation, the inaccessibility of large sections of the plant due to high radiation levels and difficult analytical problems.

Although the IAEA has somewhat more experience safeguarding reprocessing plants than enrichment plants, it has not undertaken the routine application of safeguards to any commercial reprocessing plant on a long-term basis. It has conducted safeguard experiments and exercises at the Nuclear Fuel Services Plant, West Valley, N.Y. (plutonium throughput of 300 kg/year), and at the

Eurochemic plant in Mol, Belgium (plutonium throughput 500 kg/year). Operation of both these facilities has been suspended indefinitely. Currently, IAEA has experimental safeguard projects at the two Italian pilot plants at Sallugia and Itrex (plutonium throughput 64 kg/year). The proposed Safeguards Technical Manual procedures for spent-fuel reprocessing have been drafted but have not yet been published. The safeguarding of reprocessing plants is treated in a very general way in INFCIRC/66/Rev. 2. INFCIRC/153, paragraph 80(b) states that for any facility involving more than 5 kg of plutonium, the Agency may expend at least 1.5 man years of inspection effort. This insures almost continuous inspection, even for very small reprocessing plants.

Table 6 in appendix V of volume II lists existing and planned reprocessing facilities worldwide. It can be seen that there is only one commercial facility in operation, and that most of the facilities to be subject to IAEA safeguards in the next 5 years or so have design capacities of no more than 2,500 kg of plutonium throughput per year. However, the Allied General (AGNS) plant at Barnwell, S.C., has a design capacity of 15,000 kg of plutonium throughput per year, and cost studies indicate that plants of this size or larger are the most economical. Therefore, this discussion will be referenced to a plant with plutonium throughput of 15,000 kg per year.

NRC requirements call for a 50 percent chance of detection by the materials accountancy system of a diversion of 1 percent of the throughput, with a materials balance taken every 6 months. This means that a *diverter* would run a 50 percent chance of being caught by the materials accountancy system if he diverted 75 kg of plutonium in 6 months from the reference plant. One might argue that 50 percent is too high a risk for the diverter; in that case he could content himself with 10 kg in 6 months with only a 5 percent chance of detection by the materials accountancy system. (The numbers are slightly different for the IAEA.)

For the IAEA, the expected accuracy of material balance is lower; the allowable false-alarm rate, although not yet set, may be lower; and the frequency of inventory is higher. These differences will not qualitatively change the conclusion of this analysis. Looking at the situation from the operator's point of view, he can be 95 percent confident of detecting a diversion of over 120 kg from the reference plant within a 6 month period. That is, if the materials accountancy system does *not* call a theft, all the operator can say is that he is 95 percent certain that a theft, if it did occur, was less than 120 kg.

Moreover, as one industry reviewer noted: "The conclusions regarding the probability of 'calling' a discrepancy fail to take cognizance of efforts to resolve the discrepancy prior to 'calling.' Since the 'calling' would undoubtedly entail added cost and inconvenience to the operator, there would be significant effort to resolve the discrepancy with the possibility of introducing an unsuspected bias."

The above discussion reveals that the detection of diversion from a large reprocessing plant by the present materials accounting systems is not very sensitive to quantities of the order of tens of kilograms, nor, more important, is the detection *timely*. That is, detection would occur weeks or months after the diversion.

Both NRC and IAEA therefore require a variety of surveillance and containment systems. These, coupled with physical security systems and personnel (for domestic safeguards) and resident IAEA inspectors (for IAEA safeguards), would make diversion (a) more difficult, and (b) enhance the probability of timely detection. The development, installation, and prosecution of such systems is one of the most important safeguarding tasks to be accomplished.

An important distinction should be made between the non-state diverter and the national diverter.

Although a better understanding of the likely behavior of the white-collar embezzler-adversary and advances in the state-of-the-art in evaluating safeguards systems against covert insider actions are necessary, a national safeguards and physical security system can probably be designed which, if competently implemented, would make it very difficult for a non-national diverter to covertly remove kilogram quantities of plutonium from a reprocessing plant. For example, portal monitors are presently capable of detecting gram quantities of plutonium through a moderate amount of shielding.

The safeguarding problem is more difficult in the case of the national diverter. Although resident inspectors may be able to independently verify materials balances to the accuracies discussed above through promising techniques such as isotopic correlation, diversion from the process stream undetected by the materials accounting system of the order of tens of kilograms per year would still be possible. It would be very difficult for IAEA inspectors, who have no physical security function, to detect covert removal of this material by a nation from its own reprocessing plant. In effect, the inspectors would have to rely on a prompt-reporting, tamper-indicating leak-proof perimeter containment and surveillance system. Such systems have yet to be demonstrated, but are in the early conceptual design stage.

Future of Safeguards on Enrichment and Reprocessing Plants

In contrast to IAEA's limited experience in safeguarding enrichment and reprocessing plants, Euratom has had some experience in safeguarding small enrichment facilities. After many delays, the IAEA-Euratom Safeguards Agreement is now expected to come into force within the next few months. The staffs of the two organizations have worked together for many years in anticipation of this event, but differences in safeguards approaches and the IAEA requirement to *independently* verify that diversion has not taken place will present many problems. For example, it seems certain that IAEA inspectors will be denied access to the Almelo centrifuge cascade during their inspections.

The potential diversion scenarios directly related to measurement errors in the throughput of large plants will place a heavy burden on the use of surveillance and containment as supplementary safeguard measures. In general, the United States has taken the major role in the development of unattended, tamper-resistant surveillance devices for both enrichment and reprocessing plants. Unfortunately, integrated systems tests have not been undertaken in either case.

A major U.S.-IAEA effort to test installed safeguards surveillance equipment at a reprocessing plant (General Electric Company's Midwest Fuel Recovery Plant in Morris, Ill.) was frustrated by a G.E. decision not to place the facility into operation. In the absence of a suitable U.S. enrichment facility, strong but unsuccessful efforts were made to persuade Urenco management to test U.S. enrichment plant surveillance equipment at Almelo. The United States is now considering a comprehensive perimeter safeguards system test at the Centrifuge Test Facility at Oak Ridge, Tenn.

IAEA and Euratom will not be immediately confronted with the safeguarding of very large enrichment or reprocessing plants. Given adequate manpower and technical and financial support, the safeguards systems should be able to evolve and improve as the size of facilities under safeguards increases. It is not possible to conclude at this time that this effort will be successful. There are a number of unresolved technical and political problems, any one of which might preclude credible safeguards against covert national diversion for these types of plants.

Chapter 4

International Discipline Over the Uses of Nuclear Energy

Victor Gilinsky

Both before his appointment to the Nuclear Regulatory Commission in 1975 and afterward, Victor Gilinsky has been a major contributor to discussions in the California Seminar on the risks brought on by the spread of nuclear technology. This chapter and the one that follows are based on two papers prepared by Commissioner Gilinsky in 1977. In the fast-moving field of nuclear energy policy there were significant differences in the background against which the two papers were prepared, even though separated by just over three months. In this first paper, prepared for a Seminar meeting of July 25, 1977, the emphasis is on the process of negotiating with other countries, internationalizing the control of fuel reprocessing, and explaining the nature of the bureaucratic arguments.

Over the past year the United States has been engaged in an effort to loosen the ties between civilian uses and possible military uses of nuclear energy. If we are to succeed, a fundamental change in government policy will have to be translated into an effective program to impose a stricter discipline on commercial nuclear activities thoughout the world. Implementing a policy change is always a difficult process, but here it is particularly so, because our past actions—about which we are now having second thoughts—have involved the plans and expectations of many other countries, which by now have come to view nuclear policy from their own, and sometimes quite different, perspectives.

On April 7, 1977, President Carter announced a decision to which our nuclear trading partners abroad paid close and somewhat apprehensive attention. He reaffirmed and extended President Ford's decision of the previous October to defer this country's commercial separation and use of plutonium and to ask other countries to join

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us in this course. Plutonium, you will recall, is both a fuel and a nuclear explosive material, formed in conventional nuclear fuel during the operation of a power reactor.

The action of the two presidents represented a dramatic about-face, in that it challenged our own long-held assumption that sometime in the next twenty years or so plutonium would be in wide-scale use throughout the world. We had given other nations no reason to think that such a development posed any particular dangers to world peace, so that plans to use this material commercially are quite advanced. There is little point in cataloging our past mistakes, beyond noting that our enthusiastic dissemination of the benefits of nuclear energy abroad was more often than not pursued in the name of antiproliferation.

Let me say, before I am accused of "nuclear isolationism," that there was a certain well-intentioned innocence in the notion that the best way to dissuade other nations from going after nuclear weapons was to provide them with everything nuclear but the bomb. There seemed little risk in making nuclear technology and equipment widely available, for these transfers were always accompanied by international inspection safeguards. This system, operated by the International Atomic Energy Agency (IAEA) in Vienna, was designed to follow reactor fuel through its cycle and to sound an alarm in the event of its diversion to weapons. The idea was that a reliable timely alarm—timely enough to permit international action to frustrate an illicit bomb program—would act as a deterrent to would-be violators.

SAFEGUARDS

The most obvious points are often the most easily overlooked, however, and somewhere along the way this seems to have happened to the fact that reliable timely warning was absolutely central to the safeguards rationale. Only recently, in the wake of the 1974 Indian explosion, has it been widely understood that these inspection safeguards cannot in fact protect materials such as plutonium extracted from spent nuclear fuel, for these can be turned to explosive uses in a matter of days.

So long as plutonium is locked in spent reactor fuel, it is still many time-consuming technological steps away from nuclear explosives; after separation, or reprocessing, however, the material is bomb capable. Once this happens even instantaneous discovery of its appropriation for military use will come too late; in other words, effective international response is virtually impossible. There can be no timely warning—and hence no deterrence.

A graphic illustration of the relation of inspection to deterrence can be found in airport security checks designed to deter hijackers. The airport system works because it aims at detecting an armed hijacker in the airport lobby before he or she can grab a plane. Suppose instead that security checks were performed on the plane itself after the passengers had boarded, with results radioed back to the ground after takeoff. The security information might be interesting, but it obviously would not do much to deter plane hijackings. Yet in the application of international inspections to plutonium we have been relying on the analogue of this situation.

Unfortunately, we were slow to face this dilemma. As I have pointed out, United States nonproliferation policy was based on international sharing of peaceful nuclear technology, safeguarded by the IAEA inspection system. Under this policy, a commercially important international trade developed. To suggest that IAEA protection was inadequate would thus directly question an essential underpinning of our peaceful nuclear foreign policy, to say nothing of a potentially lucrative business. This fact produced a tendency to shrink from implied dissatisfaction with IAEA safeguards: the international safeguards system was essential to commercial development of nuclear energy, and the object was to build up the system, not to "undermine" by any criticism a still delicate institution conceived and vigorously supported by the United States since 1957. The agency's own sensitivities were clearly revealed in the first reaction to the president's new policy from the IAEA's director general, who said, "I am worried about the distrust shown in the Agency's safeguards."[1]

The issue is not, however, one of distrust, but of simple fact, namely, that national plutonium stockpiles cannot be safeguarded effectively. Nothing will undermine the IAEA more than the claim that it can do something that it cannot do under the existing system of international inspections. For the fact is that the only available safeguard against sudden appropriation of a stockpile of plutonium derived from U.S. exports lies in our refusal or delay of permission to separate and store plutonium in the first place.

This situation goes to the heart of the president's new approach, which is to seek an international pause in the reprocessing of spent fuel and the separation of plutonium until some means can be devised to correct the safeguards deficiency. In support of this action the president also ordered advanced reactor research and development programs (primarily the plutonium breeder) to shift priority to fuel cycles not involving direct access to weapon-usable materials, and invited other nations to join with the United States in an evaluation of alternative directions for future nuclear energy programs. It was clearly unrealistic for the United States to ask other nations to hold up further commitments to the use of plutonium pending the installation of some kind of effective controls if we did not submit ourselves to the same discipline.

PLUTONIUM AND THE BREEDER

The international significance of this shift in policy, and the reason it will require a determined effort to implement abroad, lies in the fact that plutonium, if used to fuel the advanced breeder reactors now in the experimental stage, has long been touted as the possible key to a virtually inexhaustible source of energy and hence national energy independence. Even though plutonium's explosive properties dictate strict control, its putative potential as the fuel of the future has made it difficult to get agreement on what those controls should be, or even to get governments to acknowledge the seriousness of the proliferation problem posed by commercial use of plutonium.

Great Britain, France, Germany, and Japan have, or are planning, commercial-scale reprocessing plants. All have invested heavily in plutonium breeder development (although not as heavily as the United States has), and several are tempted by the potential international export market for the breeder and its fuel.

It was, in fact, the news of French and German sales of plutonium reprocessing plants to Pakistan and Brazil, against the background of the Indian explosion, that raised the level of alarm in the United States. It became clear that an international commercial traffic in plutonium separation facilities was being created, and this resulted in the U.S. initiative to establish an international nuclear suppliers group, in the tough nuclear export legislation now before the Congress, and in the U.S. call for an international pause in plutonium separation.

A PAUSE WITHOUT PENALTY

At this particular stage of technological development, little if any penalty will attach to holding off the commitment to plutonium. Storage of accumulating spent fuel poses few technical problems, and the plutonium contained in the spent fuel can be extracted later if needed. Supplies of natural uranium appear adequate to pemit deferral of any shift to commercial use of plutonium. Australia, Canada, the United States, and South Africa, which together possess a total of about 85 percent of the world's estimated uranium deposits, will not only be able to satisfy their own domestic needs until well after the turn of the century, but will have a substantial surplus for export.

Moreover, nuclear power plant projections, upon which world uranium needs are based, have recently shifted dramatically downward. The most recent figures show that predictions for nuclear power reactor installation by 1985 in the United States, the Federal Republic of Germany, and Japan are about half of what they were only two years ago. The Nuclear Regulatory Commission's estimate for U.S. installed nuclear capacity at the end of 1985 is now a little over 100,000 megawatts, about one-third of the AEC projection of a few years back.

What this means is that the pressures to go to the plutonium breeder have eased markedly. There is, in other words, time for the pause in plutonium separation and use sought by President Carter.

A PAINFUL REASSESSMENT

Nevertheless great anguish has been manifest. The anguish is particularly great over the fact that the president's plan to limit plutonium production at home and to discourage it abroad entails a painful reassessment of the legal instruments of our nuclear trade, some of which will have to undergo revision.

An intricate complex of treaties, agreements, international control arrangements, and extensive domestic and foreign investment is involved. It goes without saying that there are plenty of special interests presiding over and protecting the various elements of the complex. There is no question that some very hard choices will have to be made in implementing the new policy—choices that involve our alliances as well as our commerce.

Some of our nuclear allies and trading partners have complained that the reprocessing decision worked no hardship on the United States because of its rich energy resources, not available to Western Europe and Japan. It has even been suggested that the president's action was a commercial ruse dressed up as ideology.

Our efforts to influence other countries have not been aided by the U.S. nuclear industry's concerted campaign to rally foreign support against the president's program. The centerpiece of this campaign has been the contention that civilian nuclear developments do not add significantly to proliferation risks—that commercial-grade plutonium cannot be used for weapons, and that there are easier and cheaper ways to get weapons-usable plutonium than from civilian stockpiles, for example by building reactors specifically for that purpose. This line of reasoning is both technically wrong and politically naive. A nation that launches on the time-consuming course of building its own production reactor is announcing its intentions to the world and risking counteraction. But naive or not, the argument serves its primary purpose, which is to hold the line against changes in the existing rules governing our nuclear trade.

NUCLEAR TRADE AGREEMENTS

This trade with our Western European and Japanese allies, as well as with other nations, is covered by Agreements for Cooperation. These agreements basically provide that no U.S. exports may be used for "atomic weapons . . . or other military purpose" and all must be subject to IAEA inspections. They also give the United States prior approval rights over any reprocessing or retransfer of fuel supplied by the United States, a protection critically important in preventing the establishment of national plutonium stockpiles.

The agreements do not deal with nuclear materials and facilities unrelated to U.S. exports and so do not require a country to forswear nuclear explosives or accept international inspections on all of its nuclear activities. There are, moreover, important gaps in coverage even regarding use of U.S. exports. For one, the agreements do not *expressly* prohibit the use of U.S. exports for all nuclear explosives. But even though this situation has been corrected with regard to most of our trading partners—either by their ratification of the Nonproliferation Treaty or through bilateral assurances—a number have not explicitly acknowledged that the terms of our agreements exclude all nuclear explosive applications.

The most troubling loophole, however, involves U.S. approval over reprocessing, because here our control is limited to U.S.-supplied fuel used in a U.S.-exported reactor. Although it is true that most of the enriched uranium fuel now in use worldwide comes from the United States, this situation may change in the next ten years or so as enrichment facilities come into production in several of the advanced nations. If some of our present customers turn to other suppliers, we will be unable to control the disposition of an increasing amount of plutonium, even though it has been made in U.S.-supplied reactors.

In addition, there are two agreements—one with the IAEA and the other with Euratom, which provide the United States with no reprocessing controls whatsoever. Reactor and fuel sales have been made under both of these agreements.

A third problem is that ambiguities of language may affect the strength of our right to control the *re*transfer of exported material, another matter covered in the agreements. Retransfer is an issue of increasing concern because several nations are becoming interested in performing commercial reprocessing services for other nations involving our fuel.

LEGISLATION

All these deficiencies are now generally recognized and will be corrected as we enter into new Agreements for Cooperation. But there are about thirty existing agreements, and closing the loopholes in many of these is going to be a very delicate business indeed. There are differences of opinion between the Congress and the administration about how best to persuade recipient countries to agree to renegotiate the rules under which they receive U.S. exports. It is this task to which the president has recently summoned Gerard C. Smith, whose brief for the negotiations, of course, will depend on what kind of legislation emerges from the Congress.[a]

There is general agreement about what we are after in the way of controls: these are, principally, a prohibition on nuclear explosives of any kind; IAEA inspection safeguards on *all* a recipient's nuclear activities; and U.S. controls over the retransfer and reprocessing of all nuclear material produced from U.S.-exported items. But there is less agreement on the approach to this goal. The congressional bills tend to *require* acceptance of the extended controls as a condition for further exports. The administration's bill provides for *negotiating* this acceptance while continuing trade on current terms.

NEGOTIATIONS

However the problem is approached, strenuous opposition can be expected. The combination of a ban on nuclear explosives, together with the requirement of IAEA inspection safeguards on all nuclear activities, amounts to restrictions parallel to those required by the Nonproliferation Treaty, an instrument to which a number of countries, including India, Pakistan, Brazil, Argentina, Israel, Egypt, Spain, and South Africa, have not adhered.

And controls over subsequent transfers and reprocessing would sharply restrict the prerogatives currently enjoyed by the Euratom countries, which include France, Germany, and the United Kingdom. Should the administration preference for negotiation to tighten up controls prevail, the most difficult negotiation will almost certainly come with the European Community.[b]

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[a] The Nuclear Nonproliferation Act of 1978 (Public Law 95-242) was signed into law on March 10, 1978.

[b] Section 304 of the Nuclear Nonproliferation Act of 1978 adds a new Section 126 to the Atomic Energy Act of 1954. One proviso of that section is that Euratom countries need not meet, for a period of two years from the date of the enactment of the bill, criterion 4 (requiring prior U.S. approval for retransfer) or criterion 5 (requiring prior U.S. approval for reprocessing) of new Section 127 if they agree to renegotiation of the basic U.S.-Euratom agreement. Because the

Canada, now in the process of imposing tough export controls, is making slow progress with Euratom. The sticking points continue to be retransfers and reprocessing. The Europeans may be holding off to see what comes out of the American renegotiations.

It is interesting, incidentally, that Australia, which also intends to impose tough export controls, has raised the possibility of bilateral agreements with each of Euratom's member states. One Australian official is reported to have commented that "for those of us outside Euratom it is hard to see them as supranational authority . . . it's the member states and not Euratom who sign nonproliferation treaties." The Australians have taken a very tough position. "They need uranium," one high Australian official reportedly said, "more than we need to export it."

The United States, because of its existing agreements with Euratom, is in a much more difficult position as it enters the negotiations. But there is no question that a great deal turns on the outcome.

One of the difficulties in putting a hold on plutonium is that several of the major industrial nonnuclear weapons states, such as Germany and Japan, are already in possession of small reprocessing facilities, and are planning larger ones. One suggestion for getting around this problem would be to follow the path of least resistance by endorsing the status quo, allow reprocessing to go forward in those countries, and even permit commercial services for others—in other words, an expanded "nuclear club," as the nuclear weapons nations are known.

Another suggestion is to allow plutonium processing and fabrication and use within the geographical confines of the Common Market. But inevitably these ideas raise questions of discrimination and equity. Are we to allow Holland to reprocess and not Canada? Do we require Japan to seek permission to reprocess U.S.-supplied fuel and leave Germany free of this restriction?

INTERNATIONALIZING REPROCESSING CONTROL

Although the first indispensable step in tightening the rules for international nuclear commerce is for the several supplier nations to impose stricter controls on nuclear explosive materials, in particular plutonium, in the end we shall have to seek a form of universally applicable international control.

Euratom countries have failed to notify the U.S. within the thirty-day grace period provided in the act of their willingness to renegotiate the agreement, they are not eligible for this exemption until such time as they provide the requisite notification.

The line between supplier countries and importing countries is already blurred and shifting; it will tend to lose significance in time. There are also practical problems. If, for example, uranium from Canada is converted to enrichment plant feed in Britain, enriched in the United States, and fabricated in Germany, the resulting fuel may be subject to several layers of overlapping and probably diverse bilateral controls. This leads to a cat's cradle of administrative controls. Even if there are no overlapping controls, some suppliers may be more permissive than others. We clearly need a set of universally accepted standards for nuclear commerce. There is an embryonic start on this in the nuclear suppliers conference, but this expedient is only a stopgap.

I would like to propose a scheme for internationalizing reprocessing control. The necessary control provisions would be satisfied for each exporter by approval of a model agreement between the recipient and a suitable international body—perhaps an entirely new institution—embodying an undertaking not to reprocess nuclear fuel until this is permitted by the international body, rather than by any individual supplier, or any group of suppliers.

Under this scheme no reprocessing at all would be allowed to take place until the international organization makes a general finding that the world community can cope with the associated risks of proliferation—perhaps a future finding that as a consequence of the introduction of technological and institutional innovation "reprocessing can now take place without increasing the risks of proliferation beyond that of the once-through fuel cycle."

It would not be altogether novel for the United States to turn over reprocessing controls to an appropriate international entity, for it is analogous to our assignment of bilateral inspection rights to the IAEA in the 1960s. Similarly, reprocessing control provisions in our Agreements for Cooperation could provide for transfer to an international entity when it is ready and able to carry out this function. Such a transfer should be contingent on a congressional finding that "effective and enforceable international reprocessing controls are available."

The often heard criticism that the United States is trying to impose its will on trading partners can best be answered by our agreement to be bound by the same rules and the same international discipline as others. If all countries participate in the reprocessing findings, fears that the United States is trying to impose a double standard can be allayed. Such a scheme would extend and reinforce the element of restraint represented by the president's deferral of U.S. commercial reprocessing and restructuring of its breeder programs, both of which have been met with skepticism abroad.

CONCLUSION

What are the chances for President Carter's new nuclear energy policies to gain acceptance? I am obliged to say that there are dishearteningly few, inside or outside the government, who are convinced that the United States can make a difference, and who are there to plead the president's case against nuclear proliferation.

The counsels of nuclear appeasement are many. The president, they say, is overreacting to a problem of no great proportions; or, the problem is too big for the United States to undertake alone, and none will follow our lead; or, it is too late—plutonium is inevitable, proliferation is inevitable; or our example counts for little, others will continue their plans for reprocessing no matter what we do.

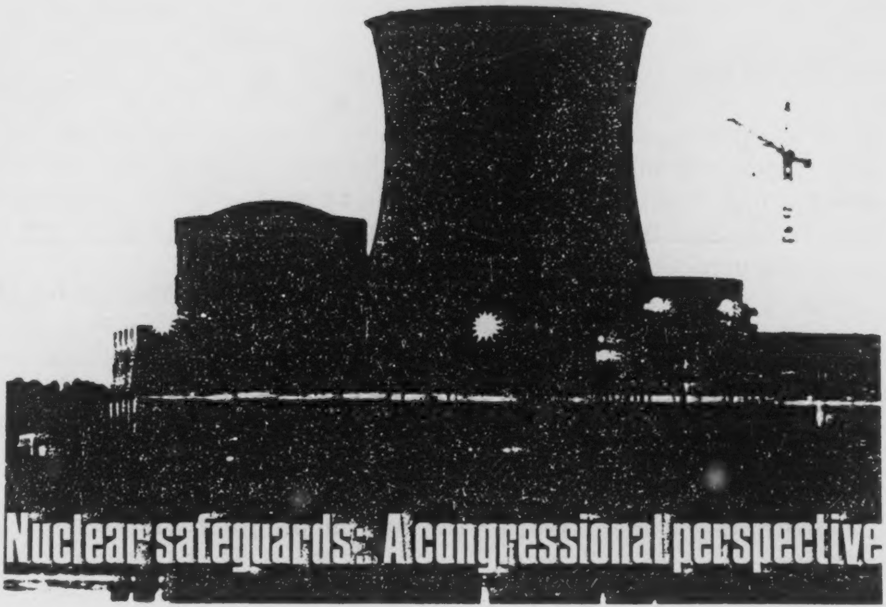
But there are also signs that others abroad are listening. What is needed now is time—time to reflect on the proliferation problem, on the nuclear energy alternatives, and on the need for stricter international discipline in the uses of nuclear energy. The president's decision to pause in the separation and use of plutonium is designed to buy that time.

For thirty years and throughout the administrations of six presidents it has been a cardinal principle of U.S. nuclear policy that at least none of our materials or equipment finds its way into the nuclear weapons of nations not already in possession of them. Yet we now know that American heavy water played a role in producing the plutonium used in the 1974 Indian nuclear explosion. Unless that lesson is taken to heart we are going to see it happen again.

And next time it will be a greal deal harder to explain to our children.

NOTE TO CHAPTER 4

1. *Nucleonics Week*, "Carter Policy Seems Damaging to U.S. Nonproliferation Credibility," Vol. 18, No. 15, April 14, 1977, pp. 1-2.



Nuclear safeguards: A congressional perspective

The Indian nuclear test woke Congress up; a Senate staff member reports on congressional efforts since then to provide more stringent controls over U.S. nuclear exports

Leonard Weiss

The culmination of nearly three years of legislative effort in the field of nuclear proliferation will occur this year when President Carter signs into law the Nuclear Non-Proliferation Act of 1978—the most comprehensive piece of nuclear legislation since the Atomic Energy Act of 1954. The Non-Proliferation Act, whose final version was that which passed the Senate by a vote of 88 to 3 on February 7, was heavily lobbied against by the nuclear industry. The House effort, led by Representatives Jonathan Bingham and Clement Zablocki, had comparatively smooth sailing; but the Senate bill was the subject of intense negotiations, mainly involving the chief sponsors, Senators John Glenn and Charles Percy, representatives of the Carter administration, and Senator James McClure—the most visible and effective critic of the legislation as reported out of three committees in the fall of 1977.

The motivating force behind this legislation, reflecting congressional concern over nuclear export policy, lies in the evolving perception of the system of nuclear safeguards. It is useful in discussing such perceptions to recall some history regarding safeguards and the world's path to nuclear development.

As Senator John Glenn has pointed out, that path can be described as one in which any nation promising no weapons development can choose the nuclear option and be aided in its choice as long as it agrees to a system of international safeguards consisting of inspection and verification through materials accounting. Most people believed, and perhaps still believe, that such a system could be made to work. But that feeling was not unanimous when such a system was first contemplated over 30 years ago.

At that time the Lilienthal committee—charged with the task of studying the international control of nuclear energy and laying the foundation for U.S. proposals for the peaceful development of nuclear energy around the world—concluded that it would *not* work:

> there is no prospect of security against atomic warfare in a system of international agreements to outlaw such weapons controlled only by a system which relied on inspection and similar police-like methods. The reasons supporting this conclusion are not merely technical, but primarily the inseparable political, social, and organizational problems involved in enforcing agreements between nations each free to develop atomic energy but only pledged not to use it for bombs. National rivalries in the development of atomic energy readily convertible to destructive purposes are the heart of the difficulty. So long as intrinsically dangerous activities may be carried on by nations, rivalries are inevitable and fears are engendered that place so great a pressure upon a system of international enforcement by police methods that no degree of ingenuity or technical competence could possibly hope to cope with them.[1]

The Lilienthal committee then recommended complete internationalization of all "dangerous" nuclear activities. (Among the activities then classified as "dangerous" were prospecting, mining and refining of uranium and thorium, enrichment, reprocessing, and research and development of nuclear explosives.) For various reasons, the Lilienthal recommendation was never implemented, and the United States went into a "holding pattern" with the passage of the Atomic Energy Act of 1946.[2]

The 1946 Act provided for no exchange of information on industrial uses of atomic energy until effective and enforceable international safeguards were established. Some loosening of these restrictions was made in 1951, mostly as a quid pro quo for receiving some needed uranium from Canada and the Belgian Congo.[3] Basically, if the common defense and security were not endangered, the Atomic Energy Commission could share some information on reactor development, processing of source materials, production of fissionable materials and related research and development.

Atoms for Peace

The big step, of course, was the 1953 Atoms for Peace proposal of the Eisenhower administration, backed up by the Atomic Energy Act of 1954, which opened the floodgates to commercial nuclear energy in the United States and allowed a mass exchange of information in many new categories, except for weapons design or manufacture. The Act provided for the expansion of nuclear exports pursuant to agreements for cooperation to be negotiated with other countries. The Commission could now approve technical assistance by persons or organizations under such agreements as long as there was no "undue risk" to the common defense and security.

When the International Atomic Energy Agency (IAEA) was formed in 1957, a further push was given toward international sharing of materials, equipment and technology. There is no better indication of how open (perhaps "loose" is the better word) we had become than the fact that at the first Atoms for Peace Conference in 1960, no fewer than six American papers appeared on the subject of Purex reprocessing technology.* Moreover, until the program was stopped in 1972, we trained 169 foreign nationals in the technology, most of whom are now working back in their native countries.[4]

Even more spectacular are the statistics on the participation of non-Soviet bloc aliens in USAEC research during the 20-year period of 1955-75. Thousands of scientists from no less than 84 countries participated. It may not be a surprise to learn that the United Kingdom was first with 1,186 participants, but India was second with 1,104 participants.[5]

The result of all this free exchange of information over a period of years has been aptly described by Theodore Taylor.[6] He points out that one can now obtain from the open literature such things as:

- computer programs for solving the neutron transport equations in forms that are applicable for the design of nuclear explosives,
- extensive data on the critical masses of a variety of combinations of fissionable materials in many types of reflectors—data that can be used for crude but workable designs of fission explosives,
- the theory of hydrodynamics in forms suitable for computer calculations for use in making calculations of the assembly and disassembly of fission explosives,
- the phases that a nuclear explosive passes through during assembly and disassembly, so that a designer can determine what he should think about and how he should think about it in analyzing a design concept,
- procedures and safety precautions required for conversion of uranium or plutonium compounds into metallic or other forms suitable for fission explosives,
- the use of high explosives on the construction of fission explosive assembly systems, and
- information on the design of fuzing and firing systems required for many different types of fission explosives.

In other words, all the basic information for the design and construction of a wide variety of fission explosives has now been published in the open technical literature. The implications of this are truly staggering.

The dimensions of this problem were becoming apparent by the mid-1960s when it then became ev-

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*Nearly every reprocessing plant built within the past 20 years has used the Purex process—a solvent extraction process (using n-tributyl phosphate) by which plutonium and uranium are separated from fission products in irradiated fuel.

ident that the projected expansion of commercial nuclear power would spread the industrial base for producing weapons material. The result was a diplomatic drive by the United States that culminated in the Nuclear Non-Proliferation Treaty. Once the Senate ratified this Treaty, the Congress returned to its previous state of somnolence on the issue.

Reprocessing

It is interesting to note that during these years our agreements for cooperation were undergoing a transformation as far as our attitude toward reprocessing was concerned. It had been assumed right from the start that reprocessing of spent fuel and the use of plutonium as a fuel would eventually become a commercial reality. After all, the known reserves of natural uranium in the late 1940s were of the order of 2,000 short tons.[7] Our agreements went through three stages: *first,* a complete veto over reprocessing in our earliest arrangements; *second,* a stage in which the retention of discretion over reprocessing was based on the acceptability of the facilities in which it was to be carried out, and a *third,* a stage in which permission to reprocess depended on the safeguardability of the facility.[8]

In any case, Congress was finally shaken out of its somnolent state on May 18, 1974, by the Indian nuclear test—made possible by the reprocessing of spent fuel from an unsafeguarded, Canadian research reactor which contained U.S. heavy water as the moderator. And the past three years have seen a rising interest both by the congressional and executive branches toward finding a solution to this most vexing of world problems. The most significant events along this line have been the introduction of comprehensive legislation on non-proliferation and the challenge to the assumption of a plutonium economy issued by former President Ford in October 1976, and carried on by President Carter in his 1977 policy announcements of April 7 and 27.

In retrospect, and admittedly with 20-20 hindsight, one may ask whether the Atoms for Peace proposal was an appropriately designed program considering the state of the art of safeguards at that time. A 1974 report commissioned by John O'Leary for the Atomic Energy Commission, and known as the Rosenbaum report, dealt with AEC safeguards to meet the threat of theft or sabotage in the nuclear industry. (The release of that report by Senator Abraham Ribicoff on April 30, 1974, was an additional factor in the rise of congressional interest in this subject at the time.)

Rosenbaum was so pessimistic about the state of safeguards that he said, in a 1975 interview:

> The sad truth is we've opened a Pandora's Box and there is no way to return to a world safe from nuclear weapons, even nuclear weapons in the hands of terrorist groups. Atoms for Peace may turn out to be one of the stupidest ideas of our time.[9]

Shades of the Lilienthal Committee Report!

If I were to sum up in one word the entire nuclear energy situation from the viewpoint of someone working in Congress, that word would be 'volatile.'

My aim in redredging this "ancient" history is not to criticize the good intentions of all those people in and out of government who labored so hard to make Atoms for Peace a living reality, but rather to provide some perspective with which to view our present situation and the future. It is not surprising, however, that there are differences of opinion in Congress and elsewhere as to where we are and, by implication, where we are going.

IAEA's Role

In relation to the activities and responsibilities of the International Atomic Energy Agency in the area of safeguards, where are we going?

First, it is well to point out that the IAEA's primary purpose has been to promote the peaceful uses of nuclear energy. Its safeguarding function was designed to complement its primary purpose to see that the nuclear assistance provided through the IAEA would not be used for military purposes. However, since the advent of the Non-Proliferation Treaty, in which all non-weapon state signatories agree to accept IAEA safeguards on all their peaceful nuclear facilities, the safeguarding role of the IAEA has expanded rapidly.

The agency is making a valiant effort to mount a safeguards program commensurate with expanding need, but it is having a difficult time. A corps of about 72 full-time inspectors (soon to be raised to about 100) are responsible for safeguarding hundreds of nuclear facilities.

Moreover, the safeguards provisions themselves appear to have been drafted in some cases with more concern for their nonintrusiveness than for their effectiveness. I am referring to such things as advance warning for most inspections, the veto right over the designated inspectors, the need for agreement by the inspected state of the defined areas or strategic points to be inspected, and the provision of applying safeguards only to declared facilities.

In addition, the IAEA does not include physical security as a safeguards function, and lacks authority to prescribe minimum standards for national systems of materials accounting and management upon which it must heavily depend in carrying out its function. The upshot is that, as the General Accounting Office noted,[10] the true effectiveness of IAEA safeguards is not known, particularly since much of the documentation for IAEA safeguards systems and the reports of its inspectors are governed by strict secrecy.*

We have no idea what IAEA data on materials unaccounted for (MUF) looks like, and don't even know if meaningful MUF data is even being collected under each national system of accounting.[11]

These comments should not be interpreted as downgrading the considerable contribution being made to the world's security and sense of well-being by the IAEA's material accounting and audit inspection system of safeguards. But we must not be blind to the differences that may exist between our safeguards needs over succeeding years and what the IAEA is prepared to provide in the way of safeguards over the same time frame.

Let me be quite specific. By some estimates, 18 countries besides the nuclear weapon states now have access to reprocessing technology. Further, the cumulative quantity of plutonium produced over the next 15 years in civilian nuclear programs around the world may top 2 million kilograms.[12] Assuming a limit of error on inventory measurements (LEMUF) of one-half of one percent, there would be a cumulative uncertainty regarding MUF of 10,000 kilograms or enough to make 1,000 weapons in the kiloton range assuming 10 kilograms of plutonium per weapon.

Obviously, if unbridled reprocessing and recycle of a significant fraction of this material occurs, we will be faced with a staggering worldwide safeguards problem which has yet to be adequately addressed. It is important to remember, as NRC commissioner Victor Gilinsky reminds us, that "the development of international material accounting safeguards schemes was predicated on the assumption that the necessary extra margin of security could only be achieved by a system which provided early warning of materials diversion."[13]

If we assume that the IAEA materials accounting and inspection system works as intended, a diversion of materials in a *once-through* light water reactor fuel cycle system, once detected, can leave us with sufficient time for a diplomatic, political or even military response to the diversion before an explosive device can be fashioned. That is, the once-through cycle possesses intrinsic safeguards through dilution of the fissionable material in the fuel, the intense radioactivity of the spent fuel, and the resulting considerable time and investment that would be needed to extract the appropriate amount of fissionable material if a reprocessing facility was not immediately available.

But consider the situation of the *closed* fuel cycle, in which stockpiles of plutonium will be produced, or the situation where a non-weapon state has access to enrichment technology and can produce stockpiles of highly enriched uranium. Under these conditions the lead time to produce a weapon once materials have been diverted can shrink to a matter of days, even hours, depending on the extent of a priori auxiliary preparations. Under such conditions, the present safeguards system no longer provides much of a barrier to weapons construction. It no longer provides sufficient time for international diplomatic pressure to be effectively applied before the assembly of a nuclear weapon is completed.

However, it is not only the stockpiling of plutonium or highly enriched uranium that provides difficulties with respect to the application of timely detection and timely warning concepts: The problems we have experienced within our own country regarding inventory differences, or material unaccounted for, also appear (and even seem to be accentuated) with the reprocessing facilities safeguarded by the IAEA.

As the Office of Technology Assessment report on *Nuclear Proliferation and Safeguards* stated:

> diversion from the process stream undetected by the materials accounting system of the order of tens of kilograms per year would . . . be possible. It would be very difficult for IAEA inspectors, who have no physical security function, to detect covert removal of this material by a nation from its own reprocessing plant. In effect, the inspectors would have to rely on a prompt-reporting, tamper-indicating, leak-proof perimeter containment and surveillance system. Such systems have yet to be demonstrated.[14]

The OTA report goes on to say that not only would the detection of diversion from a large reprocessing plant by the present materials accounting system not be very sensitive to quantities of the order of tens of kilograms, but the detection would not be *timely*. That is, detection would occur weeks or months after the diversion.

Concern Broadened

The concerns that are being expressed on this issue by numerous individuals both within and outside the Congress mark a significant change from traditional concerns about proliferation of nuclear weapons. Past non-proliferation efforts were based on an approach which was deemed to be successful as long as it forestalled the specific manufacture or acquisition of nuclear weapons. There is now substantial sentiment in the Congress that this approach is too narrow: our concerns about proliferation must be broadened to include the acquisition of the capability to quickly procure a nuclear explosive device. As Albert Wohlstetter has noted, it is possible for a nation to come within hours of explaining a nuclear device without violating any NPT rules.[15]

It is interesting to note that although there has been a prodigious amount of congressional activity in the area of nuclear proliferation over the past two years, the notion of *timely detection* and *timely warning* did not surface as a specific legislative issue until 1976 when it was raised by Rep. Clement Zablocki of the House Committee on International Relations. In a draft amendment to the Export Administration Act Rep. Zablocki sought to define safeguards for reprocessing as being effective only if there would be at least 90 days of warning time between discovery of a diversion and the earliest date at which manufacture of a nuclear explosive device could be completed. A revised version of this provision (now known as the Zablocki-Findley Amendment) was incorporated, then dropped from the bill prior to enactment.

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*Recently the NRC's Division of Nuclear Materials Safeguards and Security—as a result of an IAEA report indicating serious weaknesses in the safeguards systems in certain unnamed countries—has taken the position that it is unable to make an independent judgment of the adequacy of safeguards in connection with export licenses. The full ramifications of this event are as yet unknown; but it has resulted in a raging debate involving the Nuclear Regulatory Commission, the State Department and the Congress as to the precise role of the Commission in export licensing and the assessment of the adequacy of safeguards.

In the Senate's report on the non-proliferation bill and during the colloquies accompanying consideration of the bill on the Senate floor, the role of the NRC in this area was strongly upheld.

The principles of timely detection and timely warning were elevated to statutory status in both the House and Senate bills on nuclear proliferation (H.R. 8638 and S. 897) that were introduced in March 1977 (see box). Basically, both bills stated that the United States would not approve requests for reprocessing or retransfer of the recovered fissionable material unless

> such reprocessing or retransfer will take place under conditions that are designed to ensure the reliable detection of diversion and which would provide timely warning to the United States of such diversion well in advance of the time at which the non-nuclear weapon state could transform the diverted material into a nuclear explosive device.

The House reported its legislation before the Senate, and the Administration was silent on this provision up to that point. And, indeed, there was no reason why the Administration should not have been silent. Everything that had been said on the subject of reprocessing and plutonium—from President Carter's campaign statements to speeches by State Department officials—indicated agreement with this provision. For example, the Administration testimony given by Joseph Nye before the Senate Subcommittee on Energy, Nuclear Proliferation and Federal Services on May 6, 1977, contained the following passage:

> The central concept of safeguards is adequate warning of diversion that would provide sufficient time for diplomatic efforts to cope with the problem. But the very nature of Purex reprocessing technology means that the timely warning function of safeguards would all but vanish.

However, when the House report emerged it stated flatly that present

The Nuclear Non-Proliferation Act of 1978

The Nuclear Non-Proliferation Act of 1978 will contain, among other things, the following provisions:

- Authorization of the President to seek negotiations with other nations with a view toward establishing an International Nuclear Fuel Authority that would provide agreed-upon fuel services and allocate agreed-upon fuel resources to ensure fuel supply to nations that follow strict non-proliferation policies. As an interim measure, the President is to provide specific proposals for using part of the U.S. stockpile of low enriched uranium for fuel assurances;
- A set of export criteria (phase 1) which go into effect immediately,* and which the NRC must adopt in addition to the traditional test of inimicality to the common defense and security. These include:
  - -safeguards on all U.S. exports to non-weapon states;
  - -no use of exports for explosive devices or related R&D;
  - -adequate physical security on exports based on guidelines promulgated by the NRC;
  - -no reprocessing or retransfers of U.S. exported material without prior U.S. approval;
  - -application of preceding criteria to material or equipment produced or constructed through exported sensitive nuclear technology;
- A requirement that all parties to which we export nuclear materials adhere to full scope safeguards beginning 18 months after enactment of the legislation (phase 2);
- A cutoff of nuclear exports to non-weapon states that detonate a nuclear explosive device, terminate safeguards, abrogate a safeguards agreement, or engage in activities having direct significance for the manufacture or acquisition of nuclear explosive devices. Also, a cutoff of nuclear exports to any country that violates any guarantee given under an agreement for cooperation, aids a non-weapon state in activities having direct significance for the manufacture or acquisition of nuclear explosive devices, or enters into an agreement to transfer reprocessing equipment, materials, or technology to the sovereign control of a non-weapon state (with appropriate exceptions);
- A set of requirements to be met by new agreements for cooperation, including guarantee of adherence to the phase 1 and phase 2 criteria;
- A test to be applied (no significant increase of proliferation risk with foremost consideration given to "timely warning") in determining whether to approve reprocessing;
- A program of cooperation with developing countries in helping them meet their energy needs through the development of indigenous non-nuclear energy resources;
- Clarification of licensing procedures including time limits for certain determinations;
- A congressional review of any U.S. plan or commitment to bring back spent fuel from abroad with veto by concurrent resolution.

In the second through the fifth provisions, the executive branch was given the flexibility to escape the provision if certain findings are made; but in each instance, the Congress has the right to review such executive decisions under expedited procedures and to override those decisions by concurrent resolution.—L. W.

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*A 24-month extendable exemption from the requirement of U.S. prior approval rights on reprocessing and retransfers is granted to EURATOM and the IAEA.

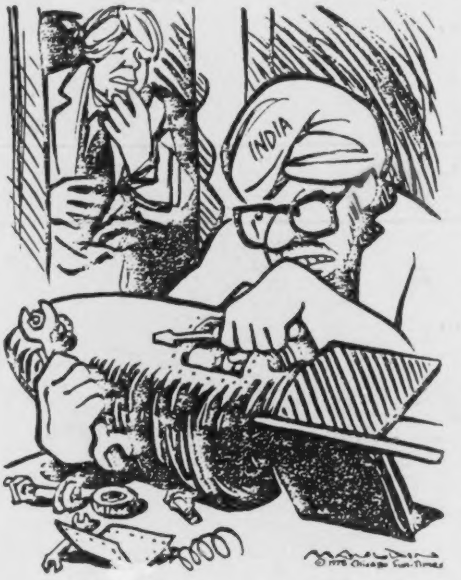
reprocessing technologies do not provide "timely warning," and that certain prominent alternative technologies might not alleviate the situation sufficiently.[16] The Administration then became concerned about the possibility of an overly rigid interpretation of the "timely warning" language. Supporters both of the industry and the Administration became temporary bedfellows in working to bottle up the House bill in the Rules Committee, while the Administration attempted to get the language both in the Senate and House bills altered to prevent "timely warning" from being the sole basis for determining whether or not to permit foreign reprocessing of U.S. fuel.

In particular, the Administration now wanted account taken of such factors as the "size and scope of the activities involved."

Last fall both the Wall Street Journal and the Washington Post implied that a change in Administration thinking had occurred, and interpreted the new Administration line as a softening of the initial resolve instilled by the President's personal views and statements. Regardless of whether that was a fair characterization or whether the Administration was simply responding to certain political realities, the fact was that the original language on timely warning had to go. So did, from Senator Glenn's viewpoint, the new formulation of the language by the Administration.

Compromise language offered by Senator Glenn was accepted by the Administration with minor modification. This language was offered by the Administration to Rep. Bingham, the principal sponsor of the House bill, who accepted it in return for getting the House bill cleared for floor action.

The legislation that is to be signed into law provides that permission for reprocessing or associated retransfer of materials will not be given unless it is found that such reprocessing or retransfer will result in "no significant increase of risk of proliferation," and further that in making such determination "foremost consideration" will be given to the principle of timely warning. While this language does suggest that other factors besides timely warning will be given consideration, the greatest weight among all factors is to go to timely warning.



"Mind your own business and pass the uranium."

Reproduced by courtesy of Wil-Jo Associates, Inc. and Bill Mauldin.

Quick and Dirty Scenario

The issue of timely warning has recently received still further attention, by implication, with the surfacing of an Oak Ridge report suggesting that a "quick and dirty" reprocessing facility can be built with off-the-shelf components in a period of 4 to 6 months.[17]

The suggestion has been made that this opens up yet another route to weapons proliferation since any non-weapon state with a nuclear power program might construct such a facility clandestinely, and reprocess spent fuel to obtain enough plutonium for a weapon within seven days. Under such conditions, it is claimed, one no longer has timely warning if a diversion of spent fuel is detected.

Until we examine in greater detail the claims made for the feasibility of clandestine construction of such a facility within the time frame indicated, we should maintain some degree of skepticism.[18] But, for the purpose of debate, suppose we take the claims at face value. What are the implications?

Certainly it means that the problem of safeguards becomes considerably more complicated. It would require, at the very least, continuous monitoring of spent fuel and, perhaps additionally, the transfer of all spent fuel from the sovereign control of non-weapon states into multinationally or internationally controlled and operated spent fuel storage facilities. And it would make nations even more jittery than they are at present as to the intentions of their neighbors under conditions of stress. But until we learn more about this "quick and dirty" reprocessing scheme, I would not assume that the timely warning principle is inapplicable.

The threshold for a decision to develop a nuclear weapon will still be higher under this "quick and dirty" scenario than if separated plutonium is already available. It is therefore not obvious, pending further clarification, that this scenario is equivalent to what is sometimes referred to as (and perhaps inaccurately) the "overnight bomb" scenario in terms of credibility and lack of safeguards.[19]

It is important to emphasize that the Non-Proliferation legislation does not create a moratorium on the reprocessing of spent fuel. In particular, the Act provides an exemption for existing reprocessing operations from immediate application of the timely warning standard. But it would be a violation of spirit of this legislation if U.S.-Japanese agreement on the reprocessing facility at Tokai Mura was used as a precedent for other such agreements. The thrust of the legislation is clear as far as reprocessing is concerned, namely, that reprocessing on a national basis should be discouraged, and that to the extent it is needed, it should go on under multinational or international auspices in a minimum number of carefully sited and managed facilities under the most effective safeguards available.

The current lack of such institutional arrangements would indeed suggest, by implication, that the Congress wishes to proceed slowly and carefully on the issue of reprocessing. That would of course be in keeping with the Administration's current policy. On the other hand, it places the Congress in a position which may be at philosophical variance with that adopted by certain members of the European community. What this may portend for the future is hard to say at this time. However, one thing is clear. Conflicting or inconsistent signals do not make for good international communication.

Certainly, the Congress would not be sending a clear message abroad concerning U.S. attitudes of safeguards and reprocessing, if legislation dealing with such matters domestically is not in philosophical consonance with legislation on such matters where other countries are involved. We cannot effectively counsel denial to others of what we insist on countenancing for ourselves. This holds for, among other things, commercial breeder reactor development, commercial reprocessing facilities and, perhaps most important, the linking of international prestige and feelings of national security to the existence of a nuclear arsenal.

One must recognize, however, that the executive branch, reflecting as it does the policy decisions of the President, is in a better position to keep a completely consistent posture in all these areas than Congress. While one cannot guarantee the future congressional posture on any issue, I believe there will be continuing and widening congressional interest and involvement in all issues concerning nuclear proliferation and safeguards. In fact, the nonproliferation legislation provides for a significant ongoing congressional role in reviewing certain executive branch proposals and decisions in the implementation of export policy; and non-proliferation policy in general.

* * *

If I were to sum up in one word the entire nuclear energy situation from the viewpoint of someone working in the Congress, that word would be "volatile." Times have changed. Not only the Congress of the United States but the general public both here and abroad are increasingly aware that decisions on energy matters which have grave implications for the security of generations to come are too important to be left in the hands of a few individuals, as was the case in the past. Future policy decisions on both sides of the oceans concerning such fundamental issues as reprocessing, the breeder, and safeguards will become increasingly subject to close scrutiny by the public and its representatives wherever representative government exists. While that may slow down the timetable of decision-making and implementation somewhat, it is a salutary step toward the redemption of our debt to the young and as-yet-unborn to whom we owe an alternative to life within a nuclear-armed crowd.

Notes

1. C. I. Barnard et al., "A Report on the International Control of Atomic Energy," prepared for the Secretary of State's Committee on Atomic Energy (Washington, D.C., March 16, 1946); see also *Bulletin* 1:8 (April 1, 1946), 2.

2. H. F. York, testimony before Senate Committee on Government Operations, Hearings on Export Reorganization Act of 1976, 94th Congress (Washington, D.C.: GPO, 1976) p. 35.

3. W. H. Donnelly, "Congress and Nonproliferation: 1954-1977," in *Stanford University Report on Congress and Arms Control* (forthcoming).

4. J. Fialka, "How We Gave Away Nuclear Control," *Washington Star*, April 3-8, 1977.

5. "Laws and Regulations Governing Nuclear Exports and Domestic and International Nuclear Safeguards," Message from the President of the United States, May 6, 1975, House Document no. 94-131.

6. T. B. Taylor, "Nuclear Safeguards," *Annual Review of Nuclear Science*, Vol. 25 (1975) pp. 407-421.

7. A. Wohlstetter, "Spreading the Bomb Without Quite Breaking the Rules," *Foreign Policy*, no. 25 (Winter 1976-77), p. 96.

8. V. Gilinsky, "Plutonium, Proliferation and Policy," Speech delivered at MIT, November 1, 1976, available as Nuclear Regulatory Commission document S-14-76.

9. J. G. Phillips, "Energy Report/Safeguards: Recycling Broadens Nuclear Power Debate," *National Journal Reports* (March 22, 1975), p. 421.

10. U.S. Comptroller General, "Role of the International Atomic Energy Agency in Safeguarding Nuclear Material," Report to the Congress, July 3, 1975, Report ID-75-63.

11. For further information and comments on International Atomic Energy Agency Material Unaccounted For data see D. Cook, "World Nuclear Unit Finds Weakness in Safeguards System," *Washington Post*, October 6, 1977, p. A20; J. Fialka, "Nuclear Safeguards Criticized," *Washington Star*, November 3, 1977.

12. T. Greenwood, H. A. Feiveson and T. B. Taylor, *Nuclear Proliferation: Motivations, Capabilities, and Strategies for Control*, 1980s Project/Council on Foreign Relations (New York: McGraw-Hill, 1977) p. 141.

13. V. Gilinsky, U.S. Senate, Committee on Energy and Natural Resources, testimony on the Nuclear Nonproliferation Act of 1977, hearings before the Senate Committee on Energy and Natural Resources, 95th Congress, September 13, 1977.

14. U.S. Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (New York: Praeger, 1977) p. 211.

15. A. Wohlstetter, testimony on Extension of the Export Administration Act of 1969, hearings before the House Committee on International Relations, June 16, 1976.

16. U.S. Congress, House of Representatives, 95th Congress, Report no. 95-587, 1977; editorial, "Rolling Mr. Carter," *Wall Street Journal*, September 16, 1977; editorial, "Controlling Nuclear Exports," *Washington Post*, September 23, 1977. See also editorial, "Mr. Carter on Weapons," *Washington Post*, October 5, 1977.

17. D. E. Ferguson to F. L. Culler, Aug. 30, 1977, Subject: Simple Quick Reprocessing Plant, Oak Ridge National Laboratory, intra-laboratory correspondence.

18. For a report that casts some doubt on the plausibility of successful clandestine construction and operation of the facility within the time frame indicated see W. H. Donnelly, "A Preliminary Analysis of the ORNL Memorandum on a Crude Nuclear Fuel Reprocessing Plant," Congressional Research Service Report to the Subcommittee on Energy, Nuclear Proliferation and Federal Services, Library of Congress, Nov. 4, 1977. A further study of this matter by the General Accounting Office is in preparation.

19. The concern of the nuclear industry as to the effect on the public of proliferation scenarios involving the diversion of separated plutonium (the "overnight bomb") has been eloquently expressed in a number of speeches by Carl Walske, President of the Atomic Industrial Forum. An account of one such speech is contained in "Overnight Bomb Scenario Bugbear of Public Debate," in *Nuclear Industry*, October 1977, pp. 12-14.

NUREG-0414, ES

SAFEGUARDING A DOMESTIC MIXED OXIDE INDUSTRY AGAINST A HYPOTHETICAL SUBNATIONAL THREAT

Executive Summary

Manuscript Completed: May 1978
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Division of Safeguards
Office of Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

FOREWORD

This document is a staff technical report. The Commission has not specifically addressed many of the policy issues in the specific context of this report, and has, therefore, not approved its conclusions. The Commission has authorized publication because it believes that the information should be available to the public.

The content of this report is current as of mid-1977 and was originally intended to provide the basis for a supplement to the generic environmental impact statement (NUREG-002) on the use of recycle plutonium in mixed-oxide fuel for light water reactors (GESMO). Its content focused on the feasibility of safeguarding a domestic U.S. mixed-oxide industry. The issues of international safeguards, the possible effect of a domestic mixed-oxide industry on international considerations, and any influence on international nuclear proliferation were beyond the scope of this report.

Prior to completion and publication of this document as an environmental impact statement, President Carter, on April 7, 1977, announced some of the conclusions he had reached following a thorough review of nuclear power issues. The issues raised by the President's statement were sufficiently fundamental to cause Commission reassessment of the course being followed with respect to GESMO. As a result of the reassessment, which included consideration of public comments and the views of the Executive Branch, the Commission announced termination of the GESMO proceedings in 42 FR 65334.

While directing the termination of the GESMO proceedings, the Commission recognized the value of making the results of the effort devoted to the study of safeguards issues available to the public. Accordingly, the NRC staff is providing such information with its publication of this document as a technical report. Thus, the information contained herein becomes publicly available for use in addressing nuclear power issues. Any questions or comments on this document should be referred to the Director, Division of Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

EXECUTIVE SUMMARY

1.0 BACKGROUND AND OVERVIEW

To aid in assessment of the proposed wide-scale use of mixed-oxide (MOX) fuel in light water nuclear reactors, the Atomic Energy Commission prepared and circulated a draft environmental impact statement in accordance with the National Environmental Policy Act of 1969. That draft statement entitled "Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors" (GESMO), was issued in August 1974.

In response to comments received, particularly from the President's Council on Environmental Quality, a decision was made by the Nuclear Regulatory Commission (successor to the Atomic Energy Commission in the regulation of the domestic nuclear industry) to proceed with preparation of a final document on the Health, Safety, and Environment portions of the GESMO and to prepare a new draft document on the Safeguards portion. This step was taken in order to assure a full assessment of the safeguards issues before reaching any decision on the wide-scale use of MOX fuel. Accordingly, in October 1975, while the final GESMO document on Health, Safety, and Environmental matters was in preparation, an effort on a Draft Safeguards Supplement was initiated. Publication of an overall cost-benefit analysis was deferred pending issuance of the Draft Safeguards Supplement.

The final version of the Health, Safety, and Environment portion of the GESMO was published in August 1976 as NUREG-0002. Evaluation of five fuel cycle alternatives is presented in that document on the basis of health, safety, and environmental--but not safeguards*--effects. The principal findings were as follows:

- The safety of reactors and fuel cycle facilities would not be significantly affected by recycle of fissile materials.
- Nonradiological environmental impacts resulting from a fuel cycle involving recycle of fissile materials from spent fuel would be slightly smaller than those from a fuel cycle without recycle.
- Plutonium recycle would extend uranium resources and reduce enrichment requirements, while requiring the reprocessing and fabrication of plutonium-containing fuels.
- While there are uncertainties, widescale recycle would probably have an overall economic advantage relative to a fuel cycle without recycle.
- Differences in health effects attributable to recycle are too small to provide a significant basis for choosing among fuel cycle options.

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*MOX industry safeguards are defined as those measures employed to prevent the theft or diversion of plutonium or plutonium compounds or the sabotage of MOX facilities or shipments.

- No waste management considerations were identified that would bar recycle of uranium and plutonium.

The safeguards implications of the MOX fuel cycle stem from the introduction into the commercial nuclear power industry of substantial quantities of strategic special nuclear material (SSNM)* as compounds of plutonium. The primary concern about plutonium is its potential for use by malefactors in a nuclear explosive or a radiological dispersal weapon. This document addresses those issues and was prepared in response to the NRC directive calling for a new Draft Safeguards Supplement for the GESMO.

Any decision on the wide-scale use of MOX fuel will include an overall cost-benefit analysis which will require weighing the potential societal benefits and the risks from such use. To that end, this report illuminates the factors which affect the risk-benefit balance, including new or incremental risks or additional burdens to society stemming from the safeguards system needed to protect a wide-scale MOX industry. The cost of safeguards systems, estimated in this document, represents a basic input into the overall cost-benefit analysis of the wide-scale use of MOX fuel. Finally, this document responds to the views on safeguards expressed by the President's Council on Environmental Quality and to public comments on the draft version of NUREG-0002.

In performing the assessment of safeguards for the wide-scale use of MOX fuel, answers were sought to three basic questions:

- What would be the potential incremental risks to society from malevolent acts directed at introducing additional quantities of plutonium in the commercial sector?**

- Could MOX in wide-scale commercial use be sufficiently well protected, under the concept of continued civil order, to assure that the risks to society from malevolent acts would be acceptably low?

- If adequate safeguards could be provided, would their economic and other societal impacts (i.e., on civil liberties, laws, institutions, physical environment, etc.) be acceptable?

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*Special nuclear material (SNM) is defined as plutonium, ^{233}U, or uranium enriched in the isotope 235. Strategic special nuclear material (SSNM) is any SNM from which a nuclear explosive can be fabricated. This includes plutonium, ^{233}U, and uranium enriched 20% or more in the 235 isotope.

**For the purposes of this report, the "commercial sector" was interpreted to mean within the United States. There are, of course, substantial international implications and potential risks with respect to nuclear arms proliferation which must be addressed before a final decision is made on reprocessing and the continued development of reprocessing technology. These important international considerations will not be discussed herein, because other Government agencies with direct responsibilities in this area, namely, Department of Energy (DOE), the Arms Control and Disarmament Agency, and the Department of State, are studying the implications of reprocessing on nuclear arms proliferation.

To answer the first question, regarding risks from malevolent acts, it was necessary to consider: (1) the characteristics of the nuclear industry and nuclear materials which exist in the United States and the changes which would be caused by the projected MOX fuel cycle industry; (2) the potential threats to that industry; and (3) the consequences if safeguards failed and a threat were successfully carried out.

A multi-step approach was used to answer the second question, whether a commercial MOX industry in the U. S. could be adequately safeguarded. First, it was necessary to analyze the protection already given to other forms of SSNM and to study the additional safeguards systems and equipment currently available for use. Then these elements were combined into a conceptual design of a safeguards system for the MOX industry. Finally, possible alternatives to this conceptual design were considered.

The third question, related to the economic and societal impacts of MOX safeguards, was addressed by comparing the burdens created by a mature MOX industry with those of an industry without recycle.

Consideration of these three questions and related issues resulted in the following principal findings:

- Use of MOX fuel would have no significant impact on the potential consequences of sabotage to nuclear reactors.

- Risk to society could exist if threats to the MOX fuel cycle industry materialized and adequate safeguards were not provided.

- By building on extensive and highly successful U.S. experience in safeguarding SSNM utilized in defense programs, in civilian (DOE) research and development, and in commercial applications, safeguards systems can be designed to protect a future MOX industry to an extent that limits the risk of theft and malevolent use of plutonium to a level believed acceptable to the public.

- The incremental burdens to society from the imposition of appropriate safeguards would consist principally of relatively small increases in MOX industry costs and in the number of individuals affected by plant security and safeguards systems. These burdens would be a minor extension into the commercial sector of those already borne in safeguarding SSNM in military and energy R&D programs.

Additional details with respect to these findings are summarized below.

2.0 POTENTIAL RISKS TO SOCIETY

The major risk to society from the wide-scale use of MOX fuels arises from the possibility that significant quantities of plutonium could, through theft or internal diversion, fall into the wrong hands and be used for fabrication of an illicit nuclear explosive or plutonium dispersal device. A lesser risk is that SNM could be dispersed through acts of sabotage. Assessing these risks requires consideration of: (1) the present uses of SSNM in commercial and Government-related industries and in the projected MOX industry; (2) potential threats to the projected MOX industry; and (3) the consequences of a successful malevolent action against that industry.

Many commercial nuclear fuel cycle facilities (eleven at present) licensed and regulated by the NRC currently handle significant quantities of SSNM. In total, the 11 facilities have a potential inventory of greater than 20 metric tons of SSNM, most of which is high-enriched uranium used in Government-sponsored fuel cycle programs. A mature MOX fuel industry would, by the year 2000, add approximately 20 commercial nuclear fuel cycle facilities and an additional inventory of SSNM in the forms of MOX and PuO_2. As indicated in Table ES.1, the plutonium inventory for a MOX fuel industry projected for the year 2000 would be 77 metric tons of the element in PuO_2 and MOX forms. Such an industry, if permitted to grow without geographical constraints, would involve approximately 2,400 shipments per year of PuO_2 and MOX.

TABLE ES.1

PROJECTED SSNM INVENTORY AT NRC-LICENSED FACILITIES
(Metric Tons)

Type of SSNM	Present	1980	1985	1990	1995	2000
High-enriched uranium[a]	>20	>20	>20	>20	>20	>20
Plutonium, metal equivalent, in various forms[b]	1	3	13	39	54	77

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[a] Assumes no major change in the size of the programs which currently utilize high-enriched uranium.

[b] Approximately 20% of this quantity would be in the form of plutonium oxide. The remainder would be in plutonium concentrations of less than 10%, primarily MOX fuel. See Section 3.2.6.

In addition to the more than 20 tons of SSNM presently being handled by NRC-licensed facilities, much larger quantities have been handled in the U.S. nuclear weapons program, and additional material is being processed by other nations in their nuclear weapons programs and in their growing nuclear power industries.

With respect to the fabrication of a nuclear explosive (the greatest potential risk from a successful theft or diversion of SSNM), the high-enriched uranium (HEU) now being safeguarded under NRC authority and the HEU and weapons-grade plutonium controlled by DOE would be as useful to an adversary as the reactor-grade plutonium oxide envisioned with wide-scale use of MOX fuel. Accordingly, the primary incremental risk to society introduced by the wide-scale use of MOX fuel would arise not from any fundamentally new problem but from the increased quantities of SSNM available within the commercial sector. The fact that reactor-grade plutonium oxide, unlike HEU, can be used as a radiological dispersal device introduces an additional incremental toxic risk.

Although the potential threat against nuclear facilities cannot be precisely defined, the following conclusions were reached regarding possible threats:

- There are people who have the skills necessary to steal SSNM and fabricate a nuclear explosive or dispersal device.

- It is conceivable that such people could be assembled and motivated to conduct a malevolent act involving SSNM.

- Although the possibility appears extremely low, if such a group should succeed in obtaining significant quantities of SSNM, a major civil disaster could result. Many thousands of casualties could result, for example, from the successful detonation of a nuclear explosive device and possibly hundreds from a plutonium dispersal device. Acts of sabotage could also create significant hazards but of a lesser order of magnitude.

- With or without a MOX fuel industry, large quantities of SSNM will exist in the U.S. in support of various DOD-related programs.

While the possibilities of illicit use of SSNM are judged to be remote, they must be considered and guarded against. These risks, however, should be viewed in light of other means of creating mass casualties, in some cases with far less difficulty, which have long existed but have never been utilized. Moreover, while the incidence of crime and terrorism, both in the U.S. and abroad, increased sharply in the 1960's, there is no substantial evidence that any individual or group has ever successfully attempted to exploit the weapons potential of SSNM for causing a civil disaster.

There is considerable uncertainty whether groups such as terrorists or organized criminals who might have the capability to acquire and utilize SSNM to cause mass casualties would desire to do so. In the past, terrorist groups have selected actions which seemed calculated to draw favorable attention of some segments of the population to their point of view, while the aim of organized criminals has been to acquire wealth. Malevolent use of SSNM would not appear to serve either of these purposes. Nevertheless, the possibility that such use might be attempted, even irrationally, cannot be dismissed.

An important question in designing a safeguards system to protect against external attack is the size of the potential attacking force. Acts by terrorist groups or criminals, whether accomplished covertly or by outright assault, have generally been performed by small groups. Participation by numbers in excess of 6 has been relatively rare, and by numbers in excess of 12 even rarer. While this experience cannot be projected precisely into the future, factors which tended in the past to keep criminal and terrorist groups small, principally fear of detection, would seem likely to continue.

3.0 CONSIDERATIONS IN DESIGNING A MOX SAFEGUARDS SYSTEM

In preparing this report, a variety of alternative safeguards systems and approaches was considered. It was concluded that a future MOX industry could be adequately protected under existing regulations along with certain upgrades of these regulations presently under consideration. In reaching this conclusion, a reference safeguards system was developed, assessed for its cost and adequacy, and then utilized as a point of departure for assessing other safeguards alternatives.

Two fundamental issues arose in assessing whether the safeguards measures considered would be effective in protecting the MOX industry:

- What level of protection and what degree of assurance regarding that protection are appropriate?
- Would there be technical, societal, commercial, or other practical constraints or uncertainties in implementing adequate safeguards?

In addressing the first of these issues, a policy determination was made that the same level of protection should be given to all compounds and blends of plutonium except those contained in irradiated fuel elements or high level wastes. The primary reason for establishing this policy was that all isotopes of plutonium are SSNM and these plutonium isotopes can be chemically separated from mixes and blends involving other elements. With respect to the irradiated fuel, it was judged that the intense radiation associated with these fuel elements (which exists with or without Pu recycle) would provide significant protection against theft. Similarly, nuclear radiation protects high-level wastes against theft, although not against sabotage.

The issues noted above were addressed from the standpoint that NRC's safeguards program for commercial licensees is part of a national safeguards structure introduced initially to protect defense-related SSNM. The structure includes three primary components: intelligence gathering, fixed site and transportation security, and recovery of lost material. For a wide-scale MOX fuel industry, only the second component, fixed site and transportation security, which involves physical security and materal control, would fall primarily within NRC's field of responsibility. The other two, intelligence and recovery operations, would remain the responsibility of other agencies such as the FBI, the National Security Council, DOE, and State and local law enforcement agencies. NRC collaborates with these other agencies in developing contingency plans for reacting to and dealing with theft or diversion, but does not participate in intelligence operations or physically take part in recovery operations.

Within this national framework for safeguards, NRC is the beneficiary of the intelligence collection capabilities developed by other agencies. Existing safeguards systems make use of but are, however, not dependent upon the timely collection of intelligence data. The safeguards for any future MOX industry would similarly make use of but not depend upon intelligence operations for their effectiveness. There are no requirements presently envisioned by the NRC to increase the collection of intelligence in order to safeguard a future MOX industry.*

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*This does not mean that the FBI or local law enforcement agencies would not attempt to gather additional information if threats or rumors indicated that a nuclear facility might be attacked or sabotaged.

No specific threat was used in designing the reference safeguards system. Rather, advantage was taken of the fact that most aspects of a properly designed safeguards system, such as barriers, detection and alarm systems, measurement systems, and guard training can be designed to be relatively independent of the magnitude of the threat. Current DOD, DOE, and NRC safeguards systems emphasize redundancy and diversity to further reduce the sensitivity of safeguards designs to assumptions concerning threat levels and capabilities. The reference safeguards system design discussed in this document also uses this approach.

The NRC is currently upgrading the required safeguards performance levels for the licensed nuclear fuel industry and for nuclear reactors. Safeguards at these facilities will be designed to protect against (a) determined, violent assaults by small groups armed with automatic weapons and explosives, possibly assisted by an insider, and (b) internal conspiracies involving employees.

The self-contained capability of the reference safeguards system described in Chapter 5 is consistent with these upgraded threat requirements. Moreover, if the support of local law enforcement agencies is considered, the reference system can confidently safeguard against an even greater external threat.

In specifying a MOX safeguards system design, emphasis was placed on technical and operational options that are either available today or are expected to be available in the near future. This was done both for design conservatism and to ensure that the societal risks and burdens imposed by MOX industry safeguards could be readily definable. As examination of possible combinations of safeguards technologies progressed, it became apparent that a system which met the design threat with high confidence could be developed employing the existing regulatory base, including planned upgrades. Accordingly, the reference system was developed within the specific requirements described in 10 CFR Parts 70 and 73, supplemented by selected upgrades. The existing regulations require that licensees implement safeguards measures which include periodic material inventories, escorted shipments, physical barriers around materials, controlled access to materials, exit searches, onsite or escort guard forces, and communications to local law enforcement agencies. The upgrades to these baseline regulations, judged necessary to meet MOX industry safeguards performance needs, include personnel clearances for security force, operating, transportation and management personnel, improved guard training and capabilities, and the use in transportation of hardened transport vehicles with additional escort vehicles and guards.

In addition to upgraded regulations for the existing industry, the NRC is also considering an approach relying on a general set of performance criteria for the design and evaluation of licensee safeguards systems. These criteria would permit licensees to meet safeguards requirements by designing systems specifically for each site. This may or may not require that different sites have different mixes of safeguards system elements. As a consequence, the reference safeguards system developed in this study is considered as but one representative approach for meeting the upgraded regulatory requirements.

In order to specify the various subsystems which comprise the reference safeguards system, it was necessary to develop models of MOX industry reprocessing, fuel fabrication, and fuel assembly facilities, and of MOX assembly storage areas at reactors in sufficient detail to permit identification of appropriate safeguards hardware, personnel, and procedures. The resulting reference system, based on numerous supporting studies and analyses, was consistent with the safeguards requirements imposed by 10 CFR Parts 70 and 73. To assure a high confidence system, a generally conservative approach was adopted.

The reference safeguards system described in this document is intended to meet seven design objectives for fixed sites and three for transport. For fixed sites the objectives are:

(1) Ensure that only authorized personnel and materials are admitted into material access areas (MAA's) and vital areas (VA's).*

(2) Ensure that only authorized activities and conditions occur within protected areas, MAA's and VA's.

(3) Ensure that only authorized movement and placement of SSNM occur within MAA's.

(4) Ensure that only authorized and confirmed forms and amounts of SSNM are removed from MAA's.

(5) Ensure timely detection of unauthorized entry into protected areas.

(6) Ensure that the response to any unauthorized activity is timely, effective, and appropriate to the particular contingency.

(7) Ensure the presence of all SSNM in the plant by location and quantity.

The three design objectives for system performance during transportation are:

(1) Restrict access to and activity in the vicinity of transports.

(2) Prevent unauthorized entry into transports or unauthorized removal of SSNM from transports.

(3) Ensure that the response to any unauthorized attempt to enter vehicles and remove materials is timely, effective, and appropriate for the particular contingency.

4.0 MEASURES EMPLOYED IN THE REFERENCE SYSTEM

The reference system uses multiple and redundant sensor systems in parallel to detect intruders at the perimeter of fixed sites. Three independent but complementary types of sensors--seismic, microwave, and closed circuit television, each deployed in a clear zone between fences--were selected from among the various types available in order to achieve reliable detection capability.

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*Material access areas are areas which contain special nuclear material. Vital areas are areas which contain material or equipment whose failure, destruction, or release could directly or indirectly endanger public health or safety by exposure to radiation.

As part of the fixed-site material control system, all personnel and material leaving an MAA would undergo a search for the presence of SSNM. A physical search or equipment for detecting the gamma radiation and neutrons emitted by isotopes of plutonium could perform this function. In this connection, studies conducted by NRC indicate that random employee searches utilizing highly sensitive hand-held devices, combined with fixed detectors employing a combination of neutron and gamma detection technologies, could, with high confidence, detect very small amounts of concealed (and even shielded) material before sizable quantities could be accumulated.

Studies also indicate that present material control methods and contemplated upgrades of these methods will ensure that diversion from, or the malevolent use of, MOX industry waste and scrap streams can be controlled by careful collection and radiation monitoring supplemented by random samplings from the streams. Specially marked and sealed containers would continue to be used in waste and scrap transport.

While the reference system is designed to protect fixed facilities against the threat of plutonium theft, it also provides protection against sabotage. Additional protection against acts of sabotage is inherent in the massive structures and certain other features required for health and safety reasons. For example, the portion of a plant used for storing or processing plutonium must be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods. Massive amounts of explosives would be required to breach these structures and disperse significant quantities of plutonium.

The safeguards measures required by the current regulatory base for protecting SSNM during transportation include escort forces, communications, vehicles that resist unauthorized entry, and arrangements for reaction forces from such sources as State police, highway patrols, and local law enforcement agencies. The reference system places primary reliance on a self-contained protection capability. Assuming that the escort guards carry the semi-automatic weapons now authorized by law, a shipment convoy could include from 6 to 12 guard/drivers,* including 2 armed drivers for the vehicle containing SSNM. The guards would ride in hardened escort vehicles, 2-3 guards per vehicle. Analysis indicates that this number could effectively deal with a substantial force of well-armed attackers.

As in the case of fixed-sites, the reference system measures designed to ward off attempts to steal plutonium from transport convoys also protect against attempts to release radiation by sabotaging shipments. The integrated container vehicles in which Pu would be shipped provide additional sabotage protection.

High-level waste from reprocessing plants is expected to be shipped as a vitreous solid in a cask built much like a spent fuel shipping cask. Radiological consequences of any attempt to sabotage a shipment and actually disperse radioactive material are judged to be sufficiently low and do not require additional physical protection measures.

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*Within this range, escort numbers would be tailored to the particular route and expected conditions. Normally, numbers would approach the low end. For routes along which re-enforcements were not readily available, or other adverse conditions existed, escort numbers could be increased.

A feature of particular importance in the reference system is the control of guard response involving the use of force. The fixed-site guard force is allowed sufficient time and flexibility to assure that their use of force is deliberate and required. The system includes perimeter features which would: (1) significantly delay the flight of employees detected with unauthorized SSNM in their possession; (2) promptly detect attempts at unauthorized entry; and (3) make certain that unauthorized entry at the perimeter requires such a degree of skill and determination as to preclude casual entry by nonviolent intruders. To give transport guards comparable time and flexibility, trucks containing SSNM would be hardened to resist penetration.

The reference system capital and annualized operating costs for the year 2000, summarized in Table ES.2, are based on NRC staff estimates and supporting studies. The capital costs, $159 million, are relatively low when compared to the billions invested for a MOX industry by the year 2000. The annualized safeguards costs of $141 million would add about 7% to the operating costs of MOX facilities and about 0.2% to the total consumer cost of MOX-generated electric power.

It was concluded that it would be easier to implement safeguards systems in future MOX facilities than in existing facilities now handling SSNM. Firstly, new facilities can be specifically designed to meet safeguards requirements. Secondly, the containment features of plutonium processing facilities required for health and safety reasons greatly simplify the problem of safeguarding the material.

In summary, no significant operational, health, safety or societal impediments to the implementation of the reference safeguards system were identified. Implementation of the reference safeguards system would not alter significantly the general character of the MOX industry or any of its facilities, and the added cost of safeguards would not be pivotal in assessing the impact of a MOX industry on the U. S. economy. Variation in assumptions concerning required protection levels and the costs of the various safeguard elements does not materially change this observation.

TABLE ES.2
SAFEGUARDS COSTS FOR MATURE MOX INDUSTRY IN THE YEAR 2000
(Millions of 1975 Dollars)

Element	Capital Costs	Annualized Operating Costs
Fuel Facilities		
Reprocessing	35.8	30.8
Fuel Fabrication	44.1	58.3
Fuel Assembly	8.8	11.5
Total, Fuel Facilities	88.7	100.6
Transportation System	51.7	35.8
Total MOX Fuel Cycle Industry	140.4	136.4
Reactors*	16.6	3.0
Added Regulation Costs	1.8	1.7
Total Safeguards Costs	158.8	141.1

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*The only reactor safeguards costs included are those associated with the protection of unirradiated MOX fuel while stored at reactor sites.

5.0 ALTERNATIVE SAFEGUARDS OPTIONS

Five alternative safeguards options were also examined. In general, these measures offer the potential for improving overall safeguards performance or reducing the societal impacts attributable to safeguards. Each was examined from the standpoints of performance improvement, economic cost, and societal and industry impacts.

The first alternative considered was the use of Federal rather than private guard forces. In the Security Agency Study published by NRC in August 1976, the use of Federal guards instead of private guards for all facilities containing SSNM was analyzed in detail. The major conclusion reached was that guard force effectiveness is essentially independent of whether the force is Federally or privately employed. In general, it was determined that guard effectiveness depends primarily on personnel qualifications, particularly motivation and training, and that appropriate Federal regulations, guidelines, and implementation procedures influencing these factors can be applied with approximately equal effectiveness to both Federal and private guard forces. Based on these findings, the Security Agency Study concluded that there was no compelling reason to enact new legislation to establish a Federal force. No unique characteristic of the materials, facilities, or safeguards in a MOX industry has been identified that would alter this basic conclusion of the Security Agency Study.

A second alternative considered was to seek changes in State gun laws to permit future MOX industry civilian guards to possess automatic weapons, as a means of increasing guard force effectiveness or permitting a reduction in the number of guards. Existing information does not indicate that automatic weapons would provide guards with a measurable and generally reliable increase in effectiveness. Accordingly, it does not seem advisable to contemplate any reduction in the total number of guards as a consequence of any presumed benefits bestowed by automatic weapons.

The third alternative considered was to blend plutonium oxide with uranium oxide early in the fuel cycle so that only dilute mixtures of plutonium would be shipped between facilities. Blended plutonium compounds are much more difficult to fabricate directly into an explosive device than pure PuO_2, and concentrations of 10% or less would require separation. The added difficulty of separating the blended materials and then constructing a nuclear explosive would give the recovery operations of law enforcement organizations additional days, perhaps weeks, in which to locate stolen material with high assurance that a workable nuclear device had not yet been assembled. For directly useable PuO_2 blends, the comparable high assurance time is only a few hours. The additional amount of blended material (as compared to PuO_2) needed to manufacture a nuclear explosive would probably not significantly affect the chances of success of external attack and theft. It might, however, aid somewhat in detecting internal theft and diversion. Depending on the blend ratio adopted, annual costs of blending to the MOX industry in the year 2000 have been estimated at between $30 million and $50 million in 1975 dollars.

A fourth alternative was the collocation (placing at the same site) of facilities performing successive steps in the MOX fuel cycle. The most significant safeguards advantage would be the virtual elimination of pure PuO_2 from the transportation links. While pure PuO_2 is expected to represent only about 12% of the shipments of all plutonium mixes and compounds requiring safeguards, it is more attractive than MOX as a starting material for constructing an illicit nuclear explosive. It is thus strategically advantageous to restrict PuO_2 shipments. Collocation appears to offer modest cost savings to a MOX industry; but if a collocated facility consisted of only one reprocessing facility and one fabrication plant and either one of these facilities had an extended shutdown due to process breakdowns or accidents, either intersite transportation of PuO_2 would be required or significant economic penalties would be incurred by the companion facility. Another concern arises from a negative public perception toward decreased industrial competition as a result of collocation.

The final alternative safeguards option considered was the use of air transportation for the shipment of PuO_2 between reprocessing facilities and fabrication plants. Successful development of crash-resistant containers appears to make this technically and legally feasible and would virtually eliminate any hazard to public safety from plutonium dispersal in the event of a crash. This alternative, like collocation and blending, has the virtue of eliminating routine surface shipment of PuO_2. The costs for air transport would be higher than for the road transport it would replace, but not significantly so, the difference being estimated at $2.3 million per year in the year 2000.

6.0 SOCIETAL AND ECONOMIC IMPACTS

The reference safeguards system would introduce certain societal and economic impacts over and above those resulting from the safeguards required to protect existing nuclear commercial facilities. These impacts would result primarily from:

- The added measures and procedures introduced to protect nuclear fuel cycle facilities when MOX is used.
- The projected increase in both the number of fuel cycle facilities handling SSNM (approximately 20 additional facilities by the year 2000) and the corresponding increase in shipment of plutonium compounds among these facilities and to MOX-using reactors (about 2,400 shipments per year by the year 2000).

Examination indicates that the societal impacts of a MOX safeguards system would not be of a fundamentally new character. Instead, they would be primarily increments to impacts already imposed upon society by measures to protect comparable material under NRC, DOE, or DOD control. Moreover, the direct impacts are likely to be confined to a rather limited number of individuals, most of whom would be employees of the nuclear industry.

In analyzing societal and economic impacts, special attention was given to those areas of concern most frequently identified by critics of plutonium recycle and by other concerned citizens. These are categorized in the summary discussion which follows as impacts on civil liberties, existing institutions, the economic well-being of industry and the public, legal issues, and the physical environment. The severity of the impact in each area of concern was examined both for the safeguards measures of the reference system and for the alternative options considered.

6.1 Impacts of the Reference System

In the area of civil liberties, the impacts identified would affect relatively few people and represent primarily extensions of existing practice:

- Portal searches and inspections contemplated for nuclear plants raise the issues of invasion of the privacy and infringement of the Fourth Amendment rights of industry employees and visitors. Experience with existing SSNM facilities and other industries (particularly the millions of personal searches conducted each year at airports) suggests that the impact of these measures would amount only to a very small quantitative extension of existing practice.

- The proposed preemployment clearance program raises concerns about invasion of privacy and possible infringement of the First Amendment rights of would-be employees. Here again, precedents involving clearances required for jobs in government; the existing SSNM industry; and such private enterprises as banks, airlines, precious metal firms, pharmaceutical companies, and private guard service companies indicate that an NRC-mandated clearance program covering approximately 21,000 guards and reactor and fuel cycle personnel would be but a minor extension of existing practice. Impacts on the general public would be limited to answering questions asked by investigators regarding prospective employees.

- Surveillance of individuals or groups for intelligence collection, often cited as an example of an adverse impact which can accompany the introduction of a wide-scale MOX industry, is not among the safeguards measures being considered. Appropriate information-collection efforts are already routinely conducted by Federal and State agencies under numerous judicial and constitutional constraints. Introduction of a MOX industry and its safeguards would not in fact require any surveillance or intelligence collection beyond what is presently needed to protect comparable facilities and material. It would merely require that the information already being collected be screened for threats to the MOX industry.

  In the event of a theft of material, activities involved in recovery of missing materials could be expected to touch upon the lives of employees and many members of the public at large. Some people fear search procedures and intensive investigative efforts requiring waiver of search warrants, use of warrants lacking particularity provisions, and infringements of First Amendment rights. Recovery operations are not NRC's responsibility and not specifically a part of NRC's proposed safeguards system; nevertheless, a review was conducted of anticipated recovery actions. The results indicate that no operations are contemplated which would arbitrarily disregard existing laws or require illegal investigative practices or procedures. Future search and recovery operations for reprocessed plutonium would have no greater potential for impacting on civil liberties than the procedures presently used for other important recovery operations, especially such operations as would be used to recover stolen nuclear weapons or stolen SSNM from any of the presently licensed facilities.

Only a few potential impacts on existing institutions were identified and their effect appears to be minor:

- A preemployment clearance program might be viewed as inserting the Federal Government into the nuclear industry's hiring process. It is estimated that in the year 2000, a clearance program would be confined to about 21,000 security and fuel cycle facilities personnel. The Government would have no greater impact on these individuals than it already has on a far larger number of civilians who do such things as dispense narcotics, handle defense secrets, or conduct the numerous other commercial activities in which participation requires Federal approval.

- Surveillance for intelligence collection is not expected to result in a change in the roles and missions of existing agencies and institutions. Any "nuclear threat"-related activity would be routinely assimilated into ongoing investigative activities. NRC would continue to exchange information and coordinate with appropriate law enforcement agencies. Any surveillance conducted would be incidental to that already routinely performed in protection of comparable facilities and materials.

- If a quantity of plutonium were ever successfully diverted or stolen, recovery activities could require some short-term withholding from the public of critical items of information. This would be no different than the limitations on news releases currently invoked by law enforcement officials during investigations of major crimes such as kidnappings, political assassinations, and major bank robberies.

The economic burden caused by implementing the reference safeguards system appears to be minimal compared to other costs associated with a MOX industry and, with the exception of certain Federal regulatory costs, would be passed on directly to the final users of electricity.

- The estimated increment in annualized MOX industry costs in the year 2000 for implementing the reference safeguards system (or the possible options considered) ranges from $141 to 200 million per year (in 1975 dollars). This includes depreciation on the fixed investment for safeguards equipment, return on capital, equipment maintenance, and guard force salaries. Safeguards would thus amount to seven to ten percent of the $2.1 billion yearly cost projected for the MOX industry in the year 2000.

- In terms of cost to the consumer of electrical power, the reference safeguards system would increase the cost to the average consumer of electricity generated with MOX fuel by 0.2% (approximately 0.1 mill per kWh) in the year 2000.

- Indirect annual costs to cover the necessary Federal regulatory activities for MOX industry safeguards in the year 2000 are estimated to be about $1.7 million in 1975 dollars.

- While no firm cost estimates have been made of liability insurance premiums to be paid by industry to cover possible third-party injuries resulting from guard force actions, these should not differ substantially from the existing costs to other industries for guard force liability coverage.

In the area of legal impacts, i.e., impacts not covered by present laws, statutes, authorities, etc., little is anticipated of a substantial nature.

- Personnel clearance programs are within the present statutory authority of NRC, and could be imposed on present NRC licensees independent of any MOX decision.

- While the use of deadly force by MOX industry private guards would be restricted by State laws to certain legally justifiable situations, the same restriction is imposed on all other civilian guard forces.

- No new legal problems are anticipated as a result of any necessary recovery operations. Any damage to the private property of innocent members of the public as the result of recovery operations appears amenable to compensation via existing laws and administrative practices.

In the area of the physical environment, the reference safeguards system is not expected to have significant impact.

6.2 Impacts of Alternative Safeguards Options

The alternative safeguards measures considered (i.e., use of Federal guards, possession of automatic weapons, blending, collocation, and air transportation) could, as noted below, introduce some societal impacts, but none is considered so significant as to seriously influence a MOX decision.

Federal Guard Force

- The use of a Federal guard force with training equal to that of private guards should have the same impact on the civil liberties of employees and the general public as would continued use of private guards.

- In the institutional area, use of Federal guards would represent an extension of Federal responsibility into the activities of private industry. This would not establish a precedent, however, given the past use of Federal guards at contractor-operated DOE-owned facilities and the expedient use of Federal marshals on commercial airlines. On the other hand, it would lead to an additional Federal bureaucracy.

- Industry impacts result if Federal guard force supervisors would find it necessary to override industry management decisions during an emergency situation.

- Should automatic weapons ever be required, it may be legally easier to empower Federal guards than private guards to use such weapons.

Possession and Use of Automatic Weapons

- Use of automatic weapons at civilian facilities not handling Federally-owned material is presently illegal in most states and could only be permitted via new legislation. If Federal regulations were to require MOX licensee guards to possess automatic weapons, an institutional problem would result unless new State legislation were adopted.

Blending

- No civil liberties impacts are foreseen from blending.

- Institutional issues might arise due to increased Government involvement in process decisions, normally the province of private industry. Such involvement is, however, not unusual in a highly regulated industry. Precedents, such as regulations forbidding the shipment of plutonium nitrate solution and liquid wastes, already exist.

- It appears that blending can be required under NRC's present statutory authority.

- Economic impacts take the form of production cost increases which would vary with the blend ratio involved. An estimated blending cost increment of $30 to $50 million would be added to the annualized safeguards costs. This represents an increase of between 21 to 35 percent to the reference safeguard system annualized cost.

Collocation

- Collocation would lead to additional Government involvement in, and an increase in the complexity of, industry siting decisions.

- Safeguards costs might be reduced slightly by collocation. The number of fixed-site guards for the industry as a whole would, for example, be somewhat lower due to economies of scale, reduction in the number of sites, and elimination of some transportation guard requirements.

- Legal issues, most of which can lend themselves to reasonable solutions, consist of selection of an equitable transition path to a cullocated industry, maintenance of competition within the industry, and grandfathering of existing facilities.

Air Transport. The societal impact of requiring the air transportation of PuO_2 (assuming that the public safety issue is resolved by the use of crash-proof containers) would be mainly in the economic area, both the initial investment cost and the annual operating cost. Ultimate cost impact on the consumer of electricity would not differ significantly from that of a ground transportation system.

The Carter Administration's response to
two questions about IAEA safeguards.

Question 23. Some analysts question the effectiveness of international safeguards. For example, the Acheson-Lilienthal report on the international control of atomic energy in 1946 stated:

"We have concluded unanimously that there is no prospect of security against atomic warfare in a system of international agreements to outlaw such weapons, controlled only by a system which relies on inspection and similar policy-like methods * * *. A system of inspection superimposed on an otherwise uncontrolled exploitation of atomic energy by national governments will not be an adequate safeguard."

More recently, a key NRC safeguards official resigned after refusing to declare IAEA safeguards reliable. On the other hand, others see IAEA safeguards as adequate for their intended purposes. What is the Administration's analysis of these doubts and the reasons for them?

Answer. It should be pointed out that the Acheson-Lilienthal statement was made in 1946, more than a decade before the establishment of the IAEA and the development of its safeguards systems. One can view the establishment of the IAEA in 1957 and the entry into force of the NPT in 1970 as measured responses to the concern expressed in the Acheson-Lilienthal report with respect to international responsibilities in the field of atomic energy.

The IAEA system is undertaking the task for which it is designed, namely to provide the means for timely detection of any national diversion to non-peaceful purposes of nuclear material placed under safeguards. It should be noted that in addition to IAEA safeguards, other methods are also utilized in the context of U.S. efforts to deal with the proliferation of nuclear weapons.

The NRC official referred to above, who resigned for reasons unrelated to the issue of IAEA safeguards reliability, was not expressing a judgment on IAEA safeguards *per se*, but was concerned with the ability of his office within the NRC to independently arrive at a determination concerning safeguards as they applied to a particular export license application.

Within the established framework of a safeguards system implemented by an international organization and inspectorate, rather than bilaterally, there are bound to be doubts as to the adequacy of safeguards. The United States is continuing its effort to remove the grounds for such doubts by advocating increased support to the IAEA, by supporting efforts for better IAEA efficiency and effectiveness, and by urging the broader use by the IAEA of status reports to the member states.

Question 24. Why are improvements still needed? Considering that the end of the fourth decade of the nuclear age is drawing near, who does safeguards technology still need so much improvement? Why are safeguards deficient despite research and development in the United States and abroad over many years?

Answer. Various needs exist to improve or modify technology to reach higher levels of efficiency and effectiveness for a growing number of installations of increasing complexity. In many cases, technical support is directed at adaptation and implementation of existing instruments and techniques in order to permit current safeguards objectives to be reached while maximising inspectorate efficiency, e.g., verifying nuclear material shipments and expanding spent fuel storage. In other cases, development efforts are motivated by the interest in achieving goals of shorter detection times.

The IAEA needs technical assistance in developing procedures for and in equipping the new regional offices which it plans to establish for carrying out safeguards responsibilities in different geographic areas. New techniques must be devised to cope with additional processes or plant designs in new and large commercial facilities coming under safeguards. Inspection procedures sometimes have to be developed so that implementation will comply with restrictions in existing safeguards arrangements.

As a result of development efforts to date, the IAEA has been able to apply safeguards, and to do so with improved effectiveness, to a growing number of facilities with increased complexity. Because of such efforts, the IAEA performance in this respect has been markedly better than would otherwise have been possible with the resources available.

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INTERNATIONAL SAFEGUARDS 1979

(By David Fischer)

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3. The Efficacy of Safeguards

The efficacy of safeguards in providing continuous assurance that no diversion is taking place depends upon both political and technical factors of which the political are of course by far the more important.

3.1 The International Political Factor

Continuous efficacy obviously depends upon the willingness of the international community, represented in this case by the Board of Governors and the General Conference of the IAEA, to continue to make available the financial resources and the qualified manpower needed by the expanding safeguards operation. The Board of Governors has a crucial role, too, in the safeguards operation since under the IAEA Statute it is the Board that must perform the quasi-judicial task of determining, in cases of doubt, whether there has been any breach of a safeguards agreement. It is the Board, moreover, which has the responsibility of reporting non-compliance direct to the Security Council and the General Assembly of the United Nations and of deciding which, amongst those sanctions that are foreseen in the Agency's Statute, should be imposed in case the State concerned fails to remedy the non-compliance. It is significant that the General Conference is not involved in these procedures and that the Board itself decides on sanctions irrespective of whatever action might be taken by the

Security Council or the General Assembly. How effective these sanctions would be is, of course, a separate question.

The unique role of the IAEA's Board explains, in part, both the desire of developing Member States of the IAEA to increase its size so that they may be more extensively represented on it, and the concern of many developed Member States that a further increase in the Board's present size (34 Members) could promote the introduction of extraneous political considerations into its discussions and detract from its capacity to exercise impartially the quasi-judicial function of determining compliance or non-compliance.

Whatever solution is found to this matter, it is obviously of crucial importance that the solution should continue to provide adequate assurance to safeguarded States that the Board will exercise this function impartially irrespective of the group of States to which the State in question belongs and irrespective of its relations with other States or with the international community.

3.2 The National Political Factor

The effective application of safeguards obviously depends on the full cooperation of the safeguarded State concerned in setting up and operating an effective system of accounting and control of nuclear material, in submitting accurate and timely reports and, in particular, in permitting international inspectors to carry out their functions without undue impediment, indeed in helping them in their tasks.

3.3 The Technical Efficacy of Safeguards

The technical efficacy of safeguards can be assessed against the technical objective, namely "the timely detection of diversion of significant quantities of nuclear material for the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection."

The three points which stand out are that detection must be "timely," that it must be possible to detect the diversion of a "significant quantity" of nuclear material and that it is not necessary to prove that the nuclear material is being used for making nuclear explosives. It is sufficient to establish that it has disappeared "for purposes unknown."

There has been considerable discussion of what is meant by "timeliness" and "significant quantities."

Significant quantities have normally been regarded as the quantities of plutonium or enriched uranium needed to manufacture a single nuclear explosive. In some circumstances and in some States the unexplained disappearance of such quantities of material might indeed be significant. In States having elaborate fuel cycles the fact that a "significant quantity" could not be accounted for at a given moment might not in fact mean that the material had been diverted but might merely result from measurement uncertainties in a large bulk-handling facility. Moreover, for the State concerned the diversion of a single "significant quantity" might make very little sense, politically speaking.

The difficulty here is, however, that an international organization cannot discriminate between its Member States and must generally apply the same yardsticks in each of them.

However, this problem should not be exaggerated. While the inspector's findings must be based, as far as possible, on standard objective criteria and, in particular, on so-called quantitative criteria (i.e., quantifiable criteria) these findings will always be subject to internal evaluation within the Secretariat and in the final analysis to evaluation by the Board of Governors which must afford the State concerned "every reasonable opportunity to furnish the Board with any necessary reassurance" (INFCIRC/153, paragraph 19).

With regard to timeliness, it is obviously desirable that safeguards should be able to detect a diversion before it is consummated by the explosion of the diverted material (in practice, of course, a diverting State might stockpile weapons-grade material and not use it for an explosion; indeed this is the more probable scenario in most cases). Now that safeguards are being increasingly applied to plants that handle nuclear explosive material (reprocessing plants, enrichment plants and plants that fabricate or otherwise process highly enriched fuel or plutonium fuel), concern about the timeliness of detection has increased. It has been realized that the concept of materials accounting on which emphasis was laid in the early 1970s might entail delays of several months before a diversion was detected. The safeguards operation has therefore placed much more emphasis on measures such as continuous inspection (or continuous instrumental surveillance) and on physical or other forms of "containment" which would either physically prevent diversion or make it possible to detect it very promptly. In practice (i.e., in the safeguards arrangements agreed to for individual plants), the soundness of this new approach has generally been accepted but there is still considerable difference of opinion about the precise figures that should be set as measurements of "timeliness" and about what can be achieved in this respect in large bulk-handling facilities.

It should also be borne in mind that these large bulk-handling facilities (reprocessing plants, enrichment plants, and plants for fabricating plutonium-uranium oxide or highly enriched uranium fuel) are still confined to a very small group of countries, most of which are Nuclear Weapon States. Outside the Nuclear Weapon States, such plants are operating and are under IAEA safeguards in the Federal Republic of Germany, Italy, and Japan. A reprocessing plant operating in India comes under IAEA safeguards from time to time when it handles safeguarded irradiated fuel. Pilot scale reprocessing plants are planned or under construction in Argentina and Brazil and will be placed under safeguards, but because of their small size these do not present the technical problems referred to in this paragraph.

It has been affirmed recently that the "central political value" of IAEA safeguards is to give time for diplomatic pressure to be brought to bear on a "diverting" country after the IAEA has detected the diversion but before the State concerned has been able to consummate its intentions by exploding a nuclear device. If the State is operating a reprocessing plant or has a store of plutonium or highly enriched uranium, the time needed to make the explosive may be a matter of weeks or even days--too short, in other words, for diplomatic action to be effective. This has been one of the main arguments used in proposing a delay in the construction of reprocessing plants and the introduction of fast breeder reactors.

Most of us would agree that it would be desirable to concentrate the production of enriched uranium and the separation of plutonium in as few locations as possible, and to undertake it in truly commercial large plants operated, if possible, under multinational auspices. In other words, nations should perceive that their interest lies in voluntary restraint on the number and dispersion of plants that produce weapons-grade material.

The concept that the main purpose of safeguards is to serve as a burglar alarm which would give time to the diplomatic police to rush in before the safe is blown open represents, however, a complete reversal of the basic concept of IAEA safeguards that has been accepted for the last 24 years. It also focuses attention on the risk of "abrupt" diversion in supposedly unstable Third World countries, ignoring the fact that most of the wars of the last 200 years have been launched by the richest nations. Finally, it represents a rather improbable diversion scenario.

If clandestine diversion ever does take place, the more probable scenario is that of the so-called "trickle" diversion under which relatively small quantities of weapons-grade material are quietly salted away for use in case of desperate need. Abrupt diversion (or abrupt seizure of a stock of plutonium or a reprocessing plant) followed by an earlier explosion, could hardly be perceived as serving the national interest of any countries. Indeed, once a country was caught in the act, and even if it were prevented from finishing it, it would be likely to forfeit international credibility for decades, and any safeguards applied therefter in that country are likely to have lost their principal political value. In other words, the cardinal object of safeguards is to give assurance of the absence of diversion, to give assurance that the safeguarded State is not steadily diverting material for use in an emergency. If a diversion occurs this assurance is lost.

4. Conclusions

From this analysis we may identify the following priorities.

The first and foremost is to universalize the non-proliferation regime. It is of particular importance to ensure that full-scope safeguards are applied in those countries that have significant unsafeguarded plant. As we have seen, in three cases the unsafeguarded plant is producing or is capable of producing weapons-grade material. In some of these and other cases, it may not be possible, at least until there is further progress in constraining vertical proliferation, to secure the ratification of the NPT, and the more limited object of *de facto* application of full-scope safeguards may be all that can be obtained at present. *De facto* application of full-scope safeguards entails that, because of the existence of a complete mosaic of non-NPT safeguards agreements, all nuclear material and all significant nuclear plant in the country concerned is, at a given time, under IAEA safeguards. This is certainly better than significant unsafeguarded plant but from a non-proliferation point of view it is much less satisfactory, for legal as well as practical reasons, than *de jure* application of safeguards. De facto application does not, for instance, preclude the future development of an unsafeguarded domestic nuclear fuel cycle. Moreover, the individual agreements constituting the mosaic are likely to be different in many important respects such as the precise undertaking by the country concerned, duration of the agreement, technical procedures followed under its terms, and coverage of subsequent generations of nuclear material or of replicated plant.

Second, every effort must be made to secure de jure acceptance of the non-proliferation regime, by ratification of the NPT itself (or of the Tlateloco Treaty and waiver of the four conditions), by more limited agreements between neighbouring countries coupled with IAEA verification (for instance, regional or sub-regional nuclear-free zones), or by unilateral acceptance of full-scope safeguards agreements.

Third, since the actions that would have to be taken to achieve both the first and the second priorities are political, each government concerned must itself perceive that its best interests are served by accepting a non-proliferation commitment, and that the political factors at work in each country will be quite different. In other words, neither general exhortations nor negotiation by legislation are likely to have much effect; patient and persuasive diplomacy may have better chances.

It is, of course, necessary to verify that States which have ratified the NPT also conclude without delay the safeguards agreements and more detailed safeguarding arrangements ("subsidiary arrangements and facility attachments") that are needed to implement these agreements. These arrangements are also required (and sometimes difficult to negotiate) under non-NPT agreements.

Fourth, it is essential to ensure that the political base of IAEA safeguards remains secure. This means that the governing organs of the Agency must continue to perceive that it is in the common and individual interest of their members to provide adequate funds and resources to maintain an effective operation. It is particularly important to ensure that safeguarded countries will continue to perceive the Board of Governors as a body which will impartially discharge the quasi-juridicial functions that devolve on it in approving and interpreting safeguards agreements and in dealing, if it has to do so, with questions of non-compliance.

Fifth, the safeguards operation must be conducted in such a manner as to maintain and, if possible, to increase the confidence of States that, in opening their nuclear programmes to international safeguards and inspection, they are not exposing themselves unduly to the risks that valuable industrial or commercial information will be purloined; that plant operations will not be impeded or that they will be penalized in any other way in relation to their competitors; or that they will suffer any other form of prejudice to their national interests. Responsibility for these matters falls chiefly upon the Secretariat of the IAEA which must continue to be aware of and responsive to the concerns and sensitivities of safeguarded States and of the nuclear industry.

Finally, the technical effectiveness of safeguards must be maintained and enhanced. This is desirable not only to fortify the assurance given by safeguards that no diversion is taking place, but also to permit economies in the use of manpower by the introduction of instrumental surveillance and containment. Improved safeguards will permit greater reliance of quantifiable and objective criteria in reaching more precise conclusions with less delay than at present, although it is very doubtful whether it will ever be possible entirely to eliminate an element of human judgement in reaching such conclusions. It will also be necessary to develop new safeguards approaches for the large "bulk handling" plants (reprocessing, enrichment, etc.) that are now being planned, or are coming under safeguards in Nuclear Weapon States. Responsibility for the technical improvement of safeguards rests partly on the Secretariat of the IAEA but also on governments whose support is indispensable for R & D and in providing expertise to the Agency. While technical improvement of safeguards is highly desirable, it will achieve its goals only if the overriding political priorities can be met.

In time, it will also be necessary to consider new verification approaches to take account of the increasing differences in the levels of sophistication of the nuclear industries of safeguarded States. Safeguards approaches which may be quite reasonable for verifying the absence of diversion in a country which is operating only research or power reactors may no longer be appropriate in countries with highly developed nuclear industries embracing all or large parts of the nuclear fuel cycle. The evolutionary conceptualization of such new approaches will emerge in the IAEA's advisory bodies but must eventually be endorsed by its governing organs.

In conclusion, it should be recalled that IAEA safeguards are the cutting edge of almost every non-proliferation measure that has so far been applied or put forward. Safeguards would also play a part in any international scheme for limiting vertical proliferation. If the cutting edge of safeguards is blunted or if, for one reason or another, safeguards cannot be or are not being applied, the non-proliferation regime will suffer commensurate damage.

Safeguards – a new approach

By Ryukichi Imai*

International nuclear safeguards is perhaps one of the most important yet least understood subjects in the current INFCE deliberations. Without effective and credible safeguards, however, whatever institutional arrangements may be worked out lack the final assurance of nonproliferation.

To insist that any and all nuclear fuel cycle facilities are safeguardable under any circumstances is obvious nonsense. Safeguards is a difficult subject, just as verification arrangements are no more difficult or easy than the original arms control agreement. Things are more complicated because nonproliferation is arms control in anticipation, dealing with as yet non-existent nuclear weapons in unidentified countries.

There is no specific working group within INFCE entrusted with the task of working out safeguards, yet it is easy to see that at least a part of the basic proliferation concern arose from a suspicion that the international safeguards as they exist are incapable of effective operation on certain occasions. Before this question was raised, the world had been happily living on the assumption that safeguards can separate peaceful from military nuclear power. We must, therefore, look into this subject more carefully and see whether (and how) there can be effective and credible international safeguards. The contention of the author is, "yes, there can be".

Safeguards Logic

Safeguards are technical arrangements, but for them to function properly, they must be set in a proper political perspective. After all, one is dealing with such heavily political subjects as nuclear weapons, national security and sovereignty, as well as the role of nuclear industry in various countries' energy strategy for the future.

The second important point within the safeguards logic is the definition of "nuclear proliferation". From a technical view point, it may be manufacturing one nuclear explosive device. Frankly, no amount of technical fixes could deal with all possible cases of single nuclear explosive devices, so one must define the politically relevant cases of nuclear proliferation.

Once that concept is accepted, it becomes easier to think of various proliferation-resistant measures: political arrangements to make nuclear explosives acquisition irrelevant is a *very* important step; institutional rearrangements of the world's nuclear industry, where feasible, may be very useful in making proliferation more unlikely or difficult; technical ways of making the nuclear fuel cycle more proliferation resistant can be used, for making weapons-usable material less accessible or prolonging conversion time (time it takes for nuclear material to be turned into weapons components). There can be international safeguards, which, according to the definition provided in the basic document of the International Atomic Energy Agency, are means of providing for timely detection of nuclear material diversion (of significant quantity) and thereby deterring such diversion. In other words, safeguards as deterrents and not for direct prevention.

These are the starting points for consideration of any effective safeguards arrangements. However, they are often overlooked and many experts tend to handle safeguards as independent technical exercises without regard to the other important ingredients of an integral nonproliferation system. This can lead the safeguards community to an academic examination of detailed technical points of abstract diversion scenarios, within an abstract nuclear fuel cycle in an abstract country. On the other hand, if one is aware that safeguards are measures of deterrence, the political steps that will be taken after warnings are sounded are just as important as the fine structure of the warning system itself.

Confusion within the current debates

Having clarified the basic logic of safeguards, safeguards technology should not be considered as a means of straightening the entire spectrum of the international nonproliferation problems: issues should be narrowed to a manageable size. To do that, it will be useful to consider some of the most common sources of confusion within the current safeguards debates.

There are two categories. The first is issues involving specific value judgements. The role of nuclear power in the world energy strategy of the future is a difficult and often controversial subject. It is related to the future availability and costs of hydrocarbons, to the prospects of other alternative energy sources, both their resources-bases and technology forecasts and to economic growth scenarios and detailed industrial structures as reflected in energy elasticity. These issues are inevitably linked with the prospective relationship between the countries of the North and of the South.

To arrive at a universally acceptable nuclear energy strategy before meaningful nonproliferation arrangements are worked out is an impractical proposition but the world-wide discussion about nuclear power in energy production can proceed in parallel with attempts to find meaningful nonproliferation arrangements. Meanwhile it can be assumed that individual countries will pursue their own energy strategy but a number of practical steps are conceivable which might influence countries to adopt more proliferation-resistant paths to their nuclear energy goals.

There is a picture of a proliferated world, in which weapons-usable technologies and materials are so abundant that any country can manufacture explosive devices; such a world should obviously be avoided. In the practical world, however, the number of countries likely to master the complicated technology of nuclear power within this century is very limited. Whilst mindful of moral issues, one should concentrate, for the rest of the twentieth century at least, on making sure that these limited numbers of states do not become nuclear.

It is well known that for industrially advanced countries both the economic and political cost of "going nuclear" is prohibitively high when thinking about nuclear armaments which would significantly improve military security. Political arrangements to place some of the less developed countries who might otherwise be inclined toward nuclear adventurism into similar political and military conditions would be a first step towards nonproliferation. It is important to make visible, but not necessarily formal, arrangements to provide strong disincentives for such adventurism. The incentive of removing potential threats to their national security is also important. In both points above, resorting to moral value judgements and taking them as the basis of action will lead to interesting but diverging debates, while trying to deal with specific realities would make international deliberations more convergent.

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The second issue arises from confusing definitions. There can be three different steps in defining nonproliferations. A technical definition is that "no single nuclear explosive device should be manufactured" without specifying who controls whom, when and how. This definition involves the following:

- a certain amount of weapons-usable material. The amount is defined according to the type of material and its isotopic content. It will also depend on the skill of explosive manufacturers because a large amount of scrap may be generated in the process. The minimum such amount is defined as the "threshold amount".
- know-how as well as a facility for explosive manufacture and components assembling. Manufacture of weapons components and their assembly requires a very high degree of skill, quality control, and knowledge about isotopic composition details, etc. When all required conditions are met in advance, the minimum time for weapons component manufacture is defined as conversion time. An extreme conservatism is built into the current definition of threshold amount and conversion time. Like many other deterrence systems, too much conservatism contributes to instability and so it is worthwhile to conduct a major review so that some of this conservatism may be removed.

An administrative definition of state control is when "a sovereign state exercises control over its subjects to prevent sub-national attempts to manufacture unauthorized nuclear explosives", and involves control of access to know-how and explosive manufacturing facilities, when the state is in possession of them, and control of access to weapons-usable material. In both cases, administrative measures such as qualification of personnel and authorization of facilities and access controls are involved. Prevention of diversion of weapons-usable materials either by authorized persons (detection of unauthorized withdrawal) or by unauthorized persons (physical protection, etc.) is also necessary. There are a number of important considerations:

- since nuclear explosive manufacture is not as easy as people insist, the psychological threat to society is much larger than the real threat.
- in most legal systems, implementation of penalty against violation is time-consuming and difficult, whereas threat to the social security (psychological or otherwise) is very large so that effective physical protection is more important than deterrent measures.

A wrong definition of international nonproliferation would be to extrapolate from the above points and say that it is a control by the world (presumably some international organization) over non-nuclear weapons states to prevent manufacture of explosive devices. However, international organizations are operated on the basis of consensus and are very different from the relationship between a sovereign state and its subjects and while a state can always justify its monopoly on defence related matters, there is no philosophical justification on the side of nuclear weapon states.

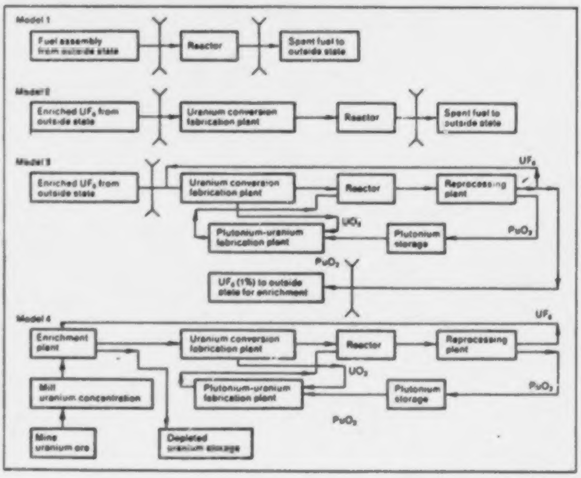
International nonproliferation is a political issue which may be stated as international efforts "not to increase the number of nuclear weapon states". There is no magic to the number "five"; the definition merely reflects political reality. Technical and administrative definitions are related but they do not represent the entire problem. Except for unusual cases, *deterrence rather than physical coercion* is the common approach in the international community. On the other hand, the safeguards procedures should be simple and objective for the purposes of implementation. Political assessment of the safeguards system are outside the scope of technical safeguards but should immediately follow them to make the entire nonproliferation regime credible. Also a political assessment of the usefulness of a single explosive device, compared with a weapons system, should be made considering the background of the countries or regions concerned.

Shortcomings in the traditional safeguards

In the recent tradition of international safeguards, when seen as a technical issue there has been too much emphasis on material accountancy and control as the single effective instrument for implementation. The essence of such an approach is to perform statistical analysis of material unaccounted for (MUF) with its expectation value set equal to zero. This approach is too narrow and in its current application has failed to take sufficient account of the fact that the fuel cycle is a *system*. A number of difficulties arise from uniform and static treatment of what is essentially a dynamic system. It is questionable how many completely satisfactory material balancings take place without the help of some supplementary measures.

Application of sampling theories to material flow in the material balance area assumes either that plants are always operated normally as planned, or that inspectors are experts in statistical theory capable of rearranging sam-

Fig. 1. Fuel cycle models to be used for nuclear material flow consistency check. The vertical, arrowed lines represent boundaries between countries.


Model 1
Fuel assembly from outside state
Reactor
Spent fuel to outside state
Model 2
Enriched UF$_6$ from outside state
Uranium conversion fabrication plant
Reactor
Spent fuel to outside state
Model 3
Enriched UF$_6$ from outside state
Uranium conversion fabrication plant
Reactor
Reprocessing plant
UF$_6$
UO$_2$
Plutonium-uranium fabrication plant
Plutonium storage
PuO$_2$
PuO$_2$
UF$_6$ (1%) to outside state for enrichment
Model 4
Enrichment plant
Uranium conversion fabrication plant
Reactor
Reprocessing plant
UF$_6$
UO$_2$
Mill uranium concentration
Plutonium-uranium fabrication plant
Plutonium storage
PuO$_2$
PuO$_2$
Mine uranium ore
Depleted uranium storage

ples according to actual operational modes.

There has been too much attention to diversion detection from low enriched uranium fuel fabrication plants and power reactors which have the lowest priority among proliferation risks. This is partly due to the emphasis on material balancing without paying enough attention to the behaviour of the national fuel cycle as a system. Since proliferation is a national event, combination of material balance based MUF into a national MUF value has to rely on somewhat arbitrarily chosen statistical methods. Since major components of MUF are *material throughput* and *measurement accuracies*, increasing the size of bulk material handling facilities means that inevitably the amount of material unaccounted for will exceed the threshold amount unless the time interval for material balance closing is unrealistically short; or the plant is divided into an unmanageably large number of material balancing areas so as to reduce the throughput; or unrealistically high accuracy of measurement is assumed. If the plant inventory is large, the problem becomes doubly difficult. Since material balancing has a comparatively long time constant for data assembly analysis, and the conversion time for some material is very short, the realistic detection time (detection interval, time it takes to perform inspections procedures, time for analysis of results) is usually longer than the conversion time. In other words, if one tries to counter an *abrupt diversion* through this method, unrealistic frequencies for taking inventories become necessary.

It is important to realise that these two problems represent the core of non-credibility in the international safeguards in many people's mind. To cope with these problems by material accountability alone efforts have been made to devise parameters describing system characteristics and effectiveness of various supplementary measures so that the ratios of control quantity to total amount and detection time to conversion time can be reduced to less than unity. The results have indicated that although one can conceive of such parameters, there are no means to quantify them, and methods of combining these parameters tend to become arbitrary.

Proposal for a new approach

The proposed new approach is based on the following major criteria, which were already well recognised at the time the Safeguards Committee of 1970 met in Vienna when the current document INFCIRC 153 was written.

- Different safeguards measures should be combined to raise the level of confidence. No single measure is considered to be 100 per cent effective.
- Providing safeguards is basically a cost/benefit exercise, namely it is a compromise between levels of proliferation risks and the benefits of the source of energy, or between the proliferator's risk of being detected against the benefits he expects from such exercise.
- National fuel cycle characteristics should play an important role in constructing different combinations of different safeguards measures.

In describing the new approach it helps to distinguish countries who are in possession of the full nuclear fuel cycle from countries which possesses reactors only and thus rely on other countries for their fuel cycle services. The latter case is the simplest because, in these countries, nuclear material is always contained in fuel assemblies and is thus accountable.

One important function of international safeguards would be to watch possible clandestine facilities capable of transforming fuel assemblies into weapons-usable form.

Although there is no formal barrier between the full fuel cycle countries and reactor-only countries they have to be treated differently when applying safeguards technology. It is important for full fuel cycle countries to agree not to transfer sensitive technologies or directly weapons-usable material without good justification to maintain the distinction between the two types of nation. This will be an important building block of the world nonproliferation regime as will fuel supply guarantee to compensate for the non-transfer of technology, or a pledge not to divert nuclear material for weapons purposes.

The basic approach should be to provide multiple safeguards against possibilities for proliferation so that not only acts of material diversion but also all weapons-oriented activities will be detected in time. Such anomalies must be sought through systems analysis of nuclear material flow within the cycle. The assumption about diverter's cost effectiveness is extremely important because the only places from which directly weapons-usable nuclear material can be diverted are so-called sensitive facilities, that is, reprocessing plant after plutonium has been separated, plutonium storage, high enrichment

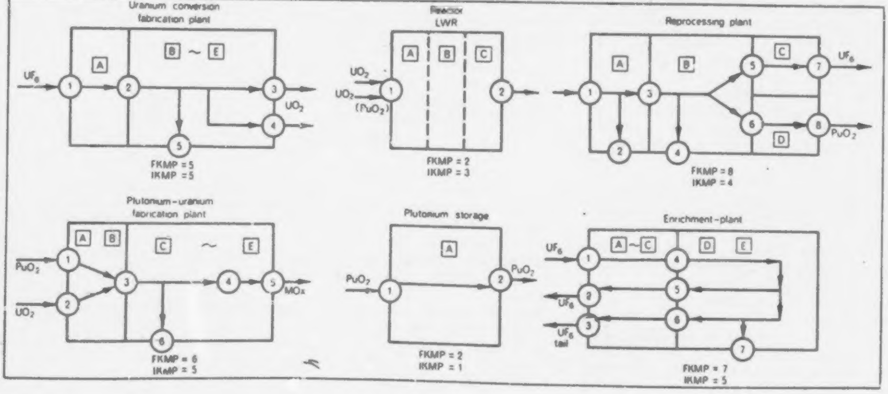


Fig. 2. Flow and inventory key measurement points in facilities used in the models. Numbers represent different flow measurement points, the letters indicate inventory measurement points.

production plant, and research facilities where these materials are directly handled. All other plants such as low enriched fuel fabrication plants or reactors only provide inputs to such sensitive facilities so any suspected attempts to build clandestine sensitive facilities or modify existing plant to achieve the same objective are in themselves clear indications of diversion intent.

Daily record keeping on a material balance area basis with the relevant data input through an integrated national computerised accounting system is needed, since the existence of an unexplained sink of nuclear material outside of such areas indicates the possibility of clandestine facilities, and an unusual pattern of flow of nuclear material within these areas (too slow or too fast) would indicate possible clandestine operations or other anomalies. Having an integrated system will enable such anomalies to be detected without delay. Action can be taken immediately to determine whether reasonable explanations can be given (plant operational troubles, recycle of scrap and reworks, etc). The purpose of this exercise is different from MUF control as such and thus the accuracy for this consistency check can be governed by other considerations than conversion time or total material absent as long as it is capable of triggering the necessary next step. International inspectors should be allowed to have full access to such material control procedures on a day-to-day basis, as well as to perform occasional record and report checks to see that they have not been falsified.

Sensitive facilities

For the sensitive facilities containment and surveillance with highly sensitive detectors, cameras and seals will be the primary safeguards tool. The purpose is to check any unauthorized or unreported removal of material. Attempts at falsifying containment or surveillance should be regarded as major violations regardless of whether actual diversion has been detected or not. The requirements of the containment/surveillance system may sometimes govern the plant design itself, while detectors sensitivity can set the maximum control rate for slow or protracted diversion. The continuous presence of inspectors may sometimes be required.

Centrifuge enrichment plant designed for production of low enriched material can be modified to produce highly enriched material. Plant modification of this magnitude will usually be under strict national control because of safety requirements. Inspectors should be admitted into the cascade hall to check that a modification is done as proposed or to see if there have been any unauthorized, unreported plant modifications. A flow balance check could be useful. If material accountancy control with total amount taken and conversion time appropriate for low enriched material accounting is also carried out, requirements for continuous assurance of containment and surveillance effectiveness for this type of plant can be reduced. For this, and other considerations, determination of weapons-usable threshold enrichment is very important.

If reprocessing plant is designed to produce pure separated Pu in easily accessible form, material accounting control will be an important supplement to containment/surveillance control. If the plant is in co-processing mode or designed so that the major part of Pu handling is inaccessible, the portion needing material accountancy control will be very much reduced, and may be limited to the scrap recovery part. It is also important to be able to detect clandestine facilities for separation of coprocessed material. Although material accountancy and control with the expected value of MUF being zero is not the first line of defence in most cases, there are portions of facilities where it is. Adoption of the schemes described here will limit such areas to the minimum.

There has always been the difficulty of quantifying effectiveness of safeguards measures of different principles. This is because people have tried, for example, to normalize the effectiveness of containment and surveillance in terms of quantity of nuclear material diverted or MUF value. The proposal here involves a different principle, and measures weapons-oriented anomaly indications or suspicions according to their adverse contribution to the entire nonproliferation system. That is one of the reasons why so much emphasis was put on the nonproliferation system discussions. Analogy may be drawn with the point system which many countries adopt for drivers' licences. This will allow expression of safeguards findings not as a statistical statement in continuous variables, but as a straightforward tabulation of discrete values. Example point systems have been worked out, but instead of giving details the guiding principle of the system is described below:

- Those offences which threaten the basic nonproliferation logic will receive the highest negative points. Construction and operation of clandestine facilities of sensitive technologies or direct diversion of weapons-useable material belong to this category.
- Violation of any one of the multiple safeguards attain the next highest marks; because sensitive facilities are surrounded by more than one safety measure a violation should be detected and its significance determined. Breaking a seal is an example of this category of violation.
- It is more difficult to quantify attempts to reduce reliability of different safeguard measures to perform assigned functions. These will more likely manifest themselves as *suspicions*. Examples in this category include inadvertent failure of seals and other security equipment or failure to notify of plant maintenance activities which could be misconstrued as a step in unauthorised modifications. Equipment failure can be analysed on the basis of mean time between failure statistics to discriminate between *inadvertent* and *wilful* failure. Other examples are repeated refusal to admit inspectors on the grounds of safety and undue delay in reporting.
- Once different points are assigned to different levels and categories of violation and suspicions, the inspector's job is simply to tabulate them, and to issue *immediate warning* to the responsible body as soon as the cumulative points exceed certain pre-set threshold values. In this context warning is not equivalent to definitive determination of diversion such as has been conceived under MUF analysis, and an investigative process that will proceed simultaneously can lead to cancellation of warning once the case in point has been cleared.

Qualifications for system type safeguards

It becomes clear from the preceding discussions that countries without a good integrated state system of material control, a credible containment/surveillance system, safeguards applied to the entire fuel cycle, safety control by the state to the extent plant maintenance or modification works of major significance are reported, assessed then approved, do not qualify to come under the fuel cycle type safeguards. States should institute credible physical protection systems as part of the nonproliferation measures.

Those unqualified countries who are in possession of some or all fuel cycle facilities will have to come under more stringent material unaccounted for control-oriented safeguards. The number of such countries is very limited because nontransfer of sensitive technologies provision will limit the scope of nuclear activities of countries without a real need and capability for a very large nuclear programme. ■

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THE PRESENT STATUS OF IAEA SAFEGUARDS
ON NUCLEAR FUEL CYCLE FACILITIES

INTRODUCTION

The purpose of this paper is to examine the present approach of the International Atomic Energy Agency (IAEA) to safeguarding various types of facilities in the nuclear fuel cycle. The Agency's Secretariat has prepared this paper in the hope that it will serve as useful background material for several of the various working groups of the International Nuclear Fuel Cycle Evaluation (INFCE). Because the interest of most of these groups are overlapping, it was decided to prepare one overall paper rather than several especially tailored for specific working groups. A paper has already been prepared for Working Group 1 on safeguarding heavy water and so this subject is not addressed in this paper.

This paper addresses the objectives and criteria of safeguards as well as the specific safeguards techniques which are utilized by the Agency. Part I is general and includes an overview of safeguards as well as a discussion of procedures applicable to most if not all IAEA safeguarded facilities. Part II is broken down into specific facility types and focusses on the particular safeguards measures applied to them. Safeguards have reached different degrees of development for different types of facilities, in part because the Agency's experience in safeguarding certain types is considerably greater than for other types. For example, the Agency has extensive experience in safeguarding thermal power reactors, particularly light water reactors. The Agency has very limited experience safeguarding fast breeder reactors (although safeguards are now being applied to several fast breeder reactors and support facilities). In the case of bulk handling facilities, the Agency has considerable experience safeguarding certain types of facilities - namely, conversion plants and fabrication plants. However, the Agency has limited experience applying safeguards to reprocessing plants and no experience safeguarding enrichment plants since such facilities have only just begun to come under safeguards. For certain types of facilities, such as enrichment and large reprocessing plants, definitive procedures have not been developed but the broad outlines of an expected Agency safeguards approach have emerged and these are discussed in this paper.

In light of the previous discussion, it almost goes without saying that Agency safeguards described herein are not static, but are continuously evolving. This evolution results not only from the fact that larger and more complex facilities have been coming under safeguards. Changes are also continually being introduced based on practical experience and research and development aimed at improving safeguards efficiency, reducing intrusiveness into plant operations, minimizing operator and inspector radiation exposure, and reducing subjective evaluations in determining the effectiveness of safeguards. To these ends, the technical support programmes of various countries are playing an important role.

Finally, it should be emphasized that this paper is not intended to evaluate the effectiveness of Agency safeguards or to highlight problem areas. It is simply aimed at providing a picture of what the safeguards are or are planned to be at various stages of the fuel cycle.

PART I GENERAL

I.A. Authority for Agency Safeguards

Article III.5 of the IAEA Statute authorizes the Agency:

> "To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose; and to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy."

States agree to accept safeguards either through "project agreements" for the supply of specific materials, equipment and facilities made available by or through the IAEA, "safeguards transfer agreements" in which States transfer to the IAEA their safeguards responsibilities set forth in their cooperation agreements, "unilateral submissions" by a State to IAEA safeguards of certrain facilities, nuclear material or all the State's nuclear activities, or agreements pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

The IAEA safeguards system is laid down in two IAEA documents, INFCIRC/66/Rev. 2 and INFCIRC/153. The first document forms the basis for project agreements, transfer agreements and unilateral submission agreements under which equipment, facilities, nuclear material, and/or other material and information are subject to safeguards. The second document forms the basis for all agreements with non-nuclear weapon (NNW) States party to the NPT, under which all nuclear material in all peaceful nuclear activities of a State is subject to safeguards. INFCIRC/153 defines the objective of safeguards and, in addition, obliges the IAEA to formulate based on certain of its verification activities, technical conclusions drawn in respect of the material unaccounted for, with regard to each material balance area. INFCIRC/66/Rev. 2 does not include the required specifics of a conclusion, but the Agency is obliged by the Statute to make a determination of compliance and, when it is determined that non-compliance has ocurred, to report to the Board of Governors. INFCIRC/66/Rev.2 provides the IAEA with means to draw in respect to nuclear material the same kind of conclusion as required by INFCIRC/153. The IAEA has to judge in each particular situation whether the application of its nuclear material verification procedures permits it to fulfill the responsibility of safeguarding equipment, facilities, non-nuclear material or items derived from technological information.

I.B. Objectives and Criteria

The basic undertaking by the State in NPT safeguards agreements is to "accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices".

The objectives of safeguards are further defined in these agreements to be the "timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection". The inclusion of the expression "for purposes unknown" is very important for the practical application of safeguards for it means that the IAEA does not have to attempt to determine the use to which diverted material is put and, in particular, does not have to determine whether nuclear material is diverted for "the manufacture of nuclear weapons or of other nuclear explosive devices".

The notions "timely detection" and "significant quantities" have been quantified in the course of the implementation of safeguards agreements. Moreover, the essential effectiveness parameters "signiificant quantity" and "detection time" have been discussed by the Standing Advisory Group on Safeguards Implementation (SAGSI), which has confirmed on a preliminary basis values used by the Secretariat for quantities of safeguards significance. Table 1 indicates these values and also shows their relationship to "threshold amounts". A "threshold amount" of nuclear material is defined as the approximate quantity of special fissionable material needed for a nuclear explosive device. A "significant quantity" of nuclear material, or a "quantity of safeguards significance", is understood to be the approximate quantity of

Table 1

THRESHOLD AMOUNTS AND QUANTITIES OF SAFEGUARDS SIGNIFICANCE

A. Threshold Amounts

Material	Threshold amount (TA)	TA applies to:
Pu (^{239}Pu>95%)	8 kg	Total element
^{233}U	8 kg	Total isotope
U (^{235}U>90-95%)	25 kg	^{235}U

B. Quantities of safeguards significance

Material		Quantity of Safeguards Significance (SQ)	SQ applies to:
"direct-use" material	Pu	8 kg	Total element
	^{233}U	8 kg	Total isotope
	U (^{235}U $\geq$ 20%)	25 kg	^{235}U
	Plus rules for mixtures where appropriate		
"indirect-use" material	U (^{235}U <20%) */	75 kg	^{235}U
	Th	20 t	Total element
	Plus rules for mixtures where appropriate		

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*/ Including natural and depleted uranium

nuclear material with respect to which - taking into account any conversion process involved - the possibility of manufacturing a nuclear explosive device cannot be excluded.

Timeliness of detection is also an essential notion for the Agency's safeguards system and must be considered carefully in the evaluation of effectiveness. The Agency's safeguards system embodies the assumption that a diversion of a significant quantity of nuclear material, be it on the basis of an abrupt or protracted diversion strategy, must be detected on a timely basis. The Agency establishes in each particular situation the frequency and timing with which it must draw a conclusion as to whether there has been no diversion, as well as the quantity of material to which the conclusion refers, the probability of detection and the probability of a false alarm. The Secretariat has developed criteria for timeliness and used them on a trial basis whenever a particular type of facility has become subject to safeguards for the first time. With regard to the precise verification of all components of the material balance which must be followed by an investigation of material unaccounted for (MUF) and by a judgement as to its causes, timeliness results primarily from the frequency of physical inventory-taking. However, in cases where the frequency of physical inventory taking and verification required to assure timeliness would seriously hamper the plant operation, timeliness must be assured by a high frequency of activities aimed at assessing the quantities of nuclear material in the plant.

The timeliness criteria were recently discussed at two meetings of SAGSI, which has made the provisional recommendation to the Director General that "detection time" be used as a parameter for timeliness and that it should correspond in order of magnitude to the "conversion time", all the qualifications attaching to the definition of these two notions being borne in mind. Generally, "conversion time" is defined as the minimum time required to convert different forms of nuclear material to the metallic components of a nuclear explosive device and "detection time" is defined as the maximum time which may elapse between a diversion and its detection by Agency safeguards. The conversion times estimated by SAGSI for different material categories are given in Table 2.

Pending the acquisition of additional practical experience and further discussions within SAGSI and other advisory groups, the Secretariat is continuing to use the values in question as guidelines.

Table 2

ESTIMATED MATERIAL CONVERSION TIMES

Material classification	Beginning material form	End process form	Estimated conversion time
1	Pu, HEU*, or ^{233}U metal	Finished plutonium or uranium metal components	order of days (7-10)
2	PuO_2, $Pu(NO_3)_4$ or other pure compounds. HEU or ^{233}U oxide or other pure compounds. MOX or other non-irradiated pure mixtures of Pu or U $[(^{233}U + {}^{235}U) \geq 20\%]$. Pu, HEU and/or ^{233}U in scrap or other miscellaneous impure compounds	"	order of weeks** (1-3)
3	Pu, HEU or ^{233}U in irradiated fuels $(\geq 10^5$ Ci/kg HEU or ^{233}U or Pu)	"	order of months (1-3)
4	U containing <20% ^{235}U and ^{233}U; thorium		order of one year

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[*] Uranium enriched to 20% or more in the isotope ^{235}U.

[**] While no single factor is completely responsible for the indicated range of 1-3 weeks for conversion of these plutonium and uranium compounds, the pure compounds will tend to be at the lower end of the range and the mixtures and scrap at the higher end.

In addition to these general guidelines for timeliness and significant quantities, the IAEA must strive for a safeguards system which has a certain probability of meeting these goals. The degree of probability with which these goals are to be met must itself be defined. Neither INFCIRC/66/Rev.2 nor INFCIRC/153 specifically mentions the concept of degree of certitude of detection, but the IAEA has interpreted these documents as implicitly embodying this concept. The a priori probability of detection which is sought is usually 90% or higher and is most often 95%.

Specific quantitative objectives for particular facilities are discussed in Part II.

I.C. Basic Concepts and Procedures

The basic approach of the IAEA to achieving the aforementioned safeguards objectives is a verification process consisting of three main aspects:

(1) The examination of the information provided by the State in:
- Design information;
- Accounting reports;
- Special reports;
- Amplification and clarification of reports; and,
- Advance notification of international transfers

(2) The collection of information by the IAEA in:
- Inspections for verification of design information;
- Ad hoc and routine inspections; and
- Special inspections

(3) The evaluation of the information provided by the State and collected in inspections for the purpose of determining the completeness, accuracy and validity of the information provided by the State.

Basic concepts for achieving the objectives of Agency safeguards, while minimizing interference with the operation of facilities are, inter alia:

- Effective monitoring of the flow of source and special fissionable material by the use of instruments and other techniques at certain strategic points;

- The periodic closing of material balances by the taking of physical inventories and their verifications; and,

- Independent verification by the Agency of the entire accounting for nuclear material subject to safeguards using chemical analysis and non-destructive measurements.

With respect to the last point, the basic principle in the IAEA safeguards system lies with a comparison between the information provided by the inspected party and the independent verification and observations performed by the Agency. The fact that potential diverters could be States, as well as facility operators, individuals or groups of individuals, makes it necessary that information supplied by the State be independently verified.

Both documents, INFCIRC/66/Rev.2 and INFCIRC/153, require that the State make available information to the Agency. Specifically, they require the State to:

- Provide the IAEA with information in respect to facility design features and other information relevant to safeguards;

- Maintain records for each facility or material balance area; and

- Provide the IAEA with reports in respect of nuclear material based on the records kept.

The existence of a domestic accountancy and control system is a prerequisite to the application of efficient international safeguards but cannot replace the latter. The Agency takes due account of the technical effectiveness of the State's system in performing its verification. Agreements of the INFCIRC/153 type require that "the State shall establish and maintain a system of accounting for and control of all nuclear material subject to safeguards....". They prescribe, inter alia, that the system shall be based on a structure of material balance areas and shall provide for establishment of a measurement system, a records and reports system, procedures for taking a physical inventory, and provisions to ensure that the accounting procedures and other arrangements are being operated correctly. INFCIRC/66/Rev.2 does not refer explicitly to a State's system of accounting for and control of nuclear material or to all of the above elements of such a system, but it does prescribe the accounting and operating records to be kept by the State and the accounting and operating reports to be submitted by the State to the IAEA.

Agency verification is accomplished by two basic means:

- material accountancy
- containment and surveillance

Nuclear material accountancy is currently the fundamental IAEA safeguards mechanism, while containment and surveillance serve as important complementary measures. Material acountancy refers to a collection of measurements and other determinations which enable the State and the Agency, in verifying the State's findings, to maintain a current picture of the location and movement of nuclear material into and out of material balance areas (MBAs).

An MBA is an area where all material entering or leaving is measureable and where an inventory of the material can be determined when necessary. The establishment of MBAs is done in consultation betwen the State and the Agency and their designation is included in Subsidiary Arrangements, which describe the "fine structure" of the agreement. Measurements are made at strategic points which are called "Key measurement points" (KMP), which are locations where essential information on flow and inventory can be gathered and verified and at which nuclear material appears in such a form as to lend itself to such measurement.

Accountancy, in the IAEA system, consists of the initial determination of physical inventory for a facility or material balance area; the perpetuation of a book inventory based on the original determination and subsequent measured inventory changes; verification and updating of the book inventory and periodic physical inventory measurements and verification; and the submission of reports to the IAEA by the State. Based on these reports, the Agency maintains a set of accounts parallel to that of the State, and these are subject to verification and comparison with the records kept at the facility. For facilities having nuclear material in unsealed bulk form, because of the measurement uncertainties, there is usually some difference between the book inventory and the physical inventory. There may also be discrepancies for other reasons, e.g., failure to measure parts of the inventory or an unmeasured loss of material or diversion. The difference between book inventory and physical inventory is the "material unaccounted for", abbreviated to "MUF". As a variable derived from measurements, MUF is, like the measurements themselves, subject to uncertainties. Thus, MUF may be a tool for judging the possibility of diversion.

A containment measure is one that takes advantage of existing structural characteristics such as containers, tanks or pipes, to establish the physical integrity of an area or item by preventing the undetected movement of nuclear material or equipment. Such measures involve the application of tamper-indicating seals or surveillance devices to ensure that any change in the inventory of that container will be detected. Such devices would not be applied to areas or structures through which material would pass as a matter of routine plant activity. If any containment measure may have been, or may have to be, breached, the Agency must be notified by the fastest means available. For example, if there is evidence that a seal has been broken or compromised in any way, immediate notification is usually required.

Surveillance refers to both human and instrumental observation aimed at indicating the movement of nuclear material. Surveillance may involve, for example, mounting cameras or other devices at strategic points to monitor containment measures or observe inventory changes. Personnel may fulfill similar assignments by manning key observation points continuously or periodically. If human surveillance by the IAEA is applied directly, the inspection access constraints as reflected in the decisions reached in the Subsidiary Arrangements negotiated with the State would of course have to be observed.

Agency containment and surveillance techniques are carefully designed and implemented to avoid imposing any additional physical restriction on the movement of or access to material; but they have to provide to the IAEA information as to whether such movement or access occurred while inspectors were not present, in order to preserve the integrity of prior measurements of nuclear material by the IAEA and to provide the IAEA with knowledge of material flows at important points in a fuel cycle.

The key to verification by the Agency is the right to conduct onsite facility inspections. The IAEA conducts three types of inspections: ad hoc, routine, and special as noted above. The majority of the inspection effort is expended on the routine inspections. The safeguards agreement specifies the maximum intensity and frequency of routine inspections. A portion of routine inspections may be of an unannounced character.

The purpose of routine inspections is to verify that the information contained in the reports submitted by the State is consistent with its accounting and operating records, to verify the location, identity, quantity and composition of safeguarded materials and to verify information on the cause of shipper/receiver differences, book inventory uncertainties, and MUF. Ad hoc inspections are made to verify design information, initial reports and changes since the initial report and to verify the material involved in international transfers. Special inspections are made to verify information in special reports or to collect additional information when the IAEA considers information provided by the State or obtained through routine inspections to be inadequate for the Agency to fulfill its responsibilities.

IAEA inspection activities include: examining pertinent records; making independent measurements on safeguarded nuclear material using IAEA equipment and also State's or operator's equipment, verifying its proper functioning, calibration and procedures; obtaining samples and ensuring their proper collection, treatment, handling and shipping; using and servicing IAEA surveillance equipment; and affixing, inspecting and removing IAEA seals.

The IAEA makes "every effort to ensure optimum cost-effectiveness and, in order to ensure it, should use, among other means, the concentration of verification procedures in those stages in the nuclear fuel cycle involving the production, processing, use or storage of nuclar material from which nuclear weapons or other nuclear explosive devices could readily be made, and minimization of verification procedures in respect of other nuclear material on condition that this does not hamper the IAEA in applying safeguards". Therefore, the statements on material unaccounted for and its limits of accuracy must not necessarily be based on equally intensive verification activities in all types of facilities or for all types of nuclear material. These activities must, however, in all cases enable the IAEA to satisfy the objective of safeguards, i.e., the timely detection of diversion of significant quantities of nuclear material. In structuring its verification system, the IAEA takes into account not only whether material can be readily made into nuclear weapons or explosives but also the relationship between various parts of the nuclear fuel cycle. For example, although low enriched uranium cannot be directly fabricated into nuclear weapons, its value as a starting point for the production of plutonium or for further enrichment cannot be overlooked.

To achieve optimum cost-effectiveness while ensuring the capability to detect diversion, the IAEA's verification system involves two different approaches, depending upon the type of nuclear facility. For facilities in which nuclear material is produced or upgraded, such as enrichment facilities and certain power reactors and the larger research reactors, and for chemical reprocessing facilities where the material produced in reactors is separated from the other components of the irradiated fuel, the verification of all flows is of critical importance. In other types of facilities, the primary inspection activity is inventory verification.

The conclusion of the IAEA's verification activities is formulated in a "statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated". It is important that the technical conclusion of the IAEA's verification activities includes an estimate of the operator's combined measurement uncertainties and the operator's MUF adjusted for any differences between the IAEA's and the operator's measurements. This technical conclusion gives an indication of the accuracy of the IAEA's measurements and of the degree of agreement between the operator's measurements and those of the IAEA.

The findings of routine inspections performed under NPT safeguards agreements are reported to the State concerned in the form of a statement. After the taking of the physical inventory, a second additional type of statement is sent to the State containing the conclusions drawn from the verification activities performed by the inspector. This statement shows if the material subject to safeguards has been satisfactorily accounted for during the period between physical inventory takings. If the Agency is not satisfied with results obtained during inspections, further investigation is called for and the State is requested to examine the causes of any inadequacy and undertake the steps necessary to remedy the situation. Statements made to the States with regard to safeguards applied pursuant to INFCIRC/66/Rev.2 agreements merely report whether the IAEA has or has not detected deviations from the terms of the agreement.

I.D. Diversion Strategies

Many diversion strategies which safeguards attempt to counter are common for several, if not all, types of nuclear facilities. For example, the diverter may allow the diverted quantity to be included in MUF. This might or might not be accompanied by an overstatement of the true measurement uncertainty of MUF. He may also attempt to prevent its appearance in MUF by the falsification of flow or inventory data. For example, he may seek to use any of the following concealment techniques:

(a) understate receipts
(b) overstate shipments or declare non-existing ones
(c) overstate discards, or
(d) overstate the physical inventory

The optimum diversion strategy is a combination of diversion into MUF and falsification of flow or inventory data. Diversion strategies as related to specific types of facilities are discussed in the appropriate sections of Part II, but most concealment techniques would fit into the general categories listed above.

PART II SAFEGUARDS APPROACHES TO SPECIFIC FACILITY TYPES

II.A. Reactors

There are some general features common to most power reactors currently under safeguards. In practically all cases reactor fuel takes the form of discrete, identifiable items (elements/assemblies). Information on the nuclear material contained in these items is generated by measurements at the fuel fabrication facility and by calculation of nuclear material loss (i.e. depletion through burn-up) and production (transmutation of fertile materials to fissile materials) at the reactor. Therefore, it is possible to determine nuclear material quantities in irradiated fuel on the basis of data generated at fuel fabrication facilities, taking into consideration material loss and production, and to validate such determination through counting and identification of items, provided that their physical integrity can be relied upon.

Reactor facilities are usually considered as one MBA with a minimum of three inventory locations as follows:

- One or more fresh fuel storage areas.
- One or more reactor core units.
- One or more spent fuel storage areas.

These inventory locations constitute inventory KMPs. Normally the only flow KMPs are those which reflect the receipt of fresh fuel and the shipment of spent fuel.

There are two basic diversion threats for reactors:

- The removal of one or more discrete elements or assemblies, with or without the substitution of falsified or partially falsified assemblies; and
- The use of safeguarded fuel for the irradiation of undeclared fertile materials (and consequent production of plutonium or U-233).

UNITED STATES NUCLEAR NONPROLIFERATION POLICY

OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY AND THE ENVIRONMENT

OF THE

COMMITTEE ON
INTERIOR AND INSULAR AFFAIRS
HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

FIRST SESSION

ON

UNITED STATES NUCLEAR NONPROLIFERATION POLICY

HEARING HELD IN WASHINGTON, D.C.
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Statements of Joseph Hendrie, Chairman, and Victor Gilinsky, Commissioner, U. S. Nuclear Regulatory Commission. (Excerpts)

Mr. **Hendrie**. Good morning, Mr. Chairman. We are pleased to be here today to testify regarding nonproliferation policies and programs and the NRC's role in these areas. In doing so I will address the specific matters identified in Mr. Udall's letter of July 17.

* * * *

A troublesome issue which we highlighted for the Congress at the time the Non-Proliferation Act was being considered, and which remains unresolved, is the question of the extent of NRC's responsibility to evaluate independently the adequacy of IAEA safeguards. The matter of adequacy is an important and proper one for consideration in the export review process. What is at issue is the degree of information concerning international safeguards programs which the Commission requires before it can make an independent determination of safeguards adequacy. The Commission is actively pursuing this matter with the Department of State in the hope of reaching agreement on means to fulfill NRC's safeguards information needs.

* * * *

As regards the ability of the international safeguards system to provide timely detection of diversion, or of other nations' efforts to acquire nuclear weapons, which you also asked that we address, this depends on the IAEA and a variety of considerations, including size and type of facility, quantities and types of material and the kinds of safeguard measures employed by the country being safeguarded. For particularly sensitive materials, such as plutonium or high-enriched uranium, the IAEA timely warning goal is 7 to 10 days. For less sensitive materials, such as low-enriched uranium or thorium, the goal is less than 1 year.

While we cannot assign an absolute overall reliability factor to Agency's program, the Commission views the IAEA safeguard system as an essential international regimen. It is subscribed to by 110 nations, and we are dedicated to improving it. In addition, the agency itself fully recognizes the importance of timely warning, and has developed goals against which to measure its performance.

Other steps are also being taken which are aimed at enhancing safeguards in particularly sensitive types of facilities. For example, continuous inspections are presently employed in at least three facilities, and application of continuous or high-frequency inspections on a broader scale is planned. As a general matter, the Commission is working closely with executive branch agencies and the national laboratories to make sure that better and more sophisticated safeguard techniques and equipment are developed and used by the Agency.

Our assistance to the Agency to date has included participation in technical and scientific working groups, loan of cost-free experts and professional training support. Incidental to the primary mission of detecting diversion of nuclear material, the inspection and verification procedures used by the Agency provide some capability to detect weapons-related activities, particularly where a continuous inspection is employed. I would note that my colleagues Bradford and Gilinsky believe this is only true to the extent that detection of diversion provides some capability to detect weapons-related activities.

* * * *

The CHAIRMAN. Thank you Chairman Hendrie. Do you have any opening comments, Mr. Gilinsky?

Mr. GILINSKY. I do not have a prepared statement, but I would like to say a few things about safeguards and their effectiveness and the difficulty the NRC and, in fact, the U.S. Government has in making assessments about the effectiveness of international safeguards.

At the heart of safeguard effectiveness is the concept of timely "warning." The term simply expresses the commonsense idea that a burglar alarm ought to go off in time to do something about the attempted theft.

In the context of nuclear diversion, it means finding out about it not when someone is at the point of turning diverted material into weapons, but at a point early enough so that you can thwart that attempt to fabricate weapons. To use an analogy, it would not do much good to protect banks with alarms if banks kept their money on the sidewalk. Particularly if a police station were some distance away. The realization that at least with materials such as highly enriched uranium and plutonium, that could easily be turned into weapons, we did have that state of affairs—that we could not count on timely warning, in effect, no matter how much inspection there was—that led President Ford and President Carter to change what had been traditional U.S. policy in this area, and to adopt a policy of discouraging further commitment to commercial use of materials that can be easily and rapidly turned into weapons.

One would like to have, of course, as much warning as possible of weapons manufacture, but implicit in our policy, I think, is the intent to keep the period between diversion and possible weapon manufacture more like months than days.

The IAEA seems to have a rather different idea of timely warning, and as the chairman pointed out, for materials that can be easily turned into weapons, which for plutonium and highly enriched uranium they estimate can be done in 7 to 10 days, they have set that period as their goal for adequate warning time. This in effect, means that one might be notified of diversion more or less simultaneously with the possible conversion of diverted material into weapons.

That strikes me as an unsatisfactory state of affairs and not a satisfactory definition of timely warning. I think it is important to understand the distinction between the definition of timely warning that is used by the IAEA and the definition that is implicit in U.S. policy.

The IAEA has now initiated a series of annual reports evaluating its safeguards systems, and I think the Agency should be commended for that, in that it is the first frank appraisal of the effectiveness of the system. The first report made clear that the goals set for IAEA's inspection system are not often met.

It is a particular concern with respect to materials that can be easily turned into weapons. The situation with respect to reactors and their fuel, low-enriched fuel, is however, a good deal better, because reactors and low-enriched fuel are some distance away from weapons use, should one decide to divert material for that purpose.

Fortunately, the ability of the system to protect against diversion of reactor fuel and to provide warning in time, is considerably greater. But the situation even there is a difficult one for us in terms of assessing the effectiveness, because the IAEA keeps information on the manner and frequency of inspection confidential. That is, in effect, the basis on which the system operates.

That leaves not only the NRC, but the U.S. Government in the dark on how this system operates in protecting specific reactors or fuel shipments or how it works in a specific country. This is a situation that I think needs to change.

We have pressed the IAEA to expand their categories of information that is made public. It is clear that too much information is in the confidential category, which was originally set up to protect proprietary information, so that countries would not lose industrial secrets through the operation of the inspection process.

But confidentiality also runs to the frequency of inspection of specific facilities, which strikes me as not being remotely proprietary. Altogether, I think there needs to be much franker discussion of the effectiveness of IAEA safeguards.

Although, such discussion is often viewed in some quarters as an attempt to undermine the IAEA; I view it as the beginning of a healthy attempt to strengthen the IAEA. The only beneficiaries, it seems to me, of avoiding such discussion are those countries that would not like to see a strengthened system. Thank you.

The CHAIRMAN Mr. Bingham?

Mr. BINGHAM. Thank you, Mr. Chairman. Chairman Hendrie, in your testimony on page 3, you say there is a question as to NRC's responsibility to evaluate independently the adequacy of international safeguards in connection with its review of export license applications. Does the NRC in fact make its own evaluation of safeguards' adequacy, or does it currently accept the evaluation made by the Department of State?

Mr. HENDRIE. We make a determination independently, Mr. Bingham, based upon the information that we are able to obtain on the subject.

Mr. BINGHAM. Are you satisfied with the information that you get from the State Department with regard to IAEA activities?

Mr. **Hendrie**. I think we get from the State Department essentially everything they have that is germane to this subject. I think in an area like safeguards, it is very hard to come to a point and say, "This is a perfectly satisfactory situation." That everything is known that could be usefully be known.

Certainly that is not the case with the level of information which we get on international safeguards. On the other hand, I think it provides a sufficient if not wholly pleasing base to make the statutory determinations. We simply ought to keep reasonable pressures and influences at work to improve the information situation and what we know about it, as well as to improve the safeguards themselves.

Mr. **Bingham**. Have there been instances where licensing decisions were made by the Commission in the absence of complete information from the administration?

Mr. **Hendrie**. Since I have absolutely no way of knowing whether I have complete information from the administration, Mr. Bingham, well I must say I cannot answer the question. The Department of State, the executive branch assures us that they come to us with all of the essential points in connection with an export, and I simply have no resource to know whether these officers of the Government are lying to me or not.

I do not believe they are, but I certainly cannot stand here and say that I have personal guarantees and proof that that is the case.

Mr. **Bingham**. Mr. Gilinsky, do you have any comments on that point?

Mr. **Gilinsky**. I think the essential point is that as a government, we do not have very much detailed information on the operation of safeguards in specific instances. We have information about the operation of the overall system, but generally not the manner in which it operates in specific countries, or with respect to specific exports.

So it is by and large not so much a problem of the NRC not having information; the problem is that the U.S. Government does not have that information. As Chairman Hendrie said, the State Department has assured us that they are supplying us with, essentially, everything that they have.

I must say there were some circumstances in which had information come more promptly it might have affected decisions, but we have had discussion with them, and they have assured us that we will be informed promptly and fully on safeguards information.

Mr. **Bingham**. Chairman Hendrie, do you have any disagreement with what Commissioner Gilinsky said earlier about his view that the IAEA's "timely warning" standard of 7 days is grossly insufficient?

Mr. **Hendrie**. My own reading is that I would think a few-days or 7-day sort of standard is probably a reasonable compromise between one's obvious desire to have a light on the wall go on the instant anything happens of a diversionary nature, and the practicalities of maintaining an international inspection system covering all the facilities that are involved and so on.

As was pointed out in the testimony, there are some facilities where the very sensitive materials are involved where the Agency has gone over to a continuous presence at the site by an IAEA inspector and some other places where high frequency inspections are contemplated, plans are underway.

It might be that over time, as we upgrade the whole system and get it some more support, that for very sensitive facilities you could provide a continuous Agency presence at the site. And I think then that a probably several-day, a 5- or 7-day standard could be maintained.

Mr. BINGHAM. It does not seem to me to give the NRC or the international community much time to react in the event of any diversion.

Mr. HENDRIE. That is certainly true, if the only indication the international community, the only inkling it has, is the signal coming down through the Agency that they believe they have observed diversion of materials. I would be surprised in any actual case, should there be one, if the sole information available to the rest of the world about such a set of actions came through the Agency and its inspection process.

American Nuclear Society
Atlantic Institute for International Affairs

INTERNATIONAL EXECUTIVE CONFERENCE
ON NON-PROLIFERATION AND SAFEGUARDS

September 7-10, 1980 - Mexico City D.F.

VIEWS FROM ARGENTINA

A.J. Carrea

Views expressed in this paper are those of the author
and not necessarily the views of the
Argentine Atomic Energy Commission (CNEA).

NON-PROLIFERATION AND SAFEGUARDS

VIEWS FROM ARGENTINA

Dr. A.J. Carrea

I will try to sketch the picture as we see it, looking from a country far away, lonesome, and stubbornly independant, keeping in mind these are views on the subject as seen from Argentina, and not necessarily the views of Argentina.

Safeguards is, in our view, only a means to reach an end, non-proliferation but,

What means proliferation?

Proliferation, nuclear proliferation, is the manufacture of nuclear weapons, nothing else. The potential capability or the potential knowledge to produce nuclear weapons, is not proliferation, it should be absolutely clear, even I am afraid it is not so to everybody. We have plenty of evidence around that, having the means or the knowledge does not necessarily imply one is proliferating (FRG, Japan, Sweden, Spain, Canada, Argentina, South Korea, Yugoslavia, Brazil, etc.).

Why nuclear proliferation does happen, or can happen?

We see, essentially, two main reasons:

a) Because one think it needs nuclear weapons to survive as nation or as a political system. Examples of this state of mind we already have: USSR and China are the best ones, possibly USA at this moment. Current speculations on the nuclear capabilities of Israel or South Africa essentially acknowledge this type of attitude.

b) As a symbol of power. One should keep up with its past, its traditions, its neighbors, its aspirations, its ambitions, and so on. We also have evidence around of this state of mind: UK, France, India. Assuming that speculations on Pakistan intentions are not proved wrong, it will fit within this group.

How nuclear proliferation could be stopped?

For those countries that feel their survival endangered, controlled disarmament is the only answer. Disarmament in this case probably means more than nuclear weapons, just because nuclear weapons are generally intended to restore some kind of "conventional" imbalance. It can also include political guarantees of some kind that, by themselves, are almost useless.

If all this sound utopical I quite agree, it is as utopical as thinking that you can stop anybody to resort to any means, including nuclear weapons, when it is fighting for its survival.

We are still faced with the second group, the status seekers. The only way to stop them from proliferating is to deprive them of the status they are seeking. Having a nuclear weapon should be a real burden, a great sin, a real stumbling block for all your dreams, not just a slight moral inconvenience. If all these sound utopical also, I should reckon the judgment is probably right but, it is not the same kind of utopia.

In the first case, to stop proliferation depends essentially on the willingness of those who feel endangered. In the second case, to deprive the nuclear weapons of their value as a status symbol depends, essentially, on those who already hold them and stick to their privileges because they have those weapons. This is the big difference between both utopias.

Let us look now to the other side of the picture as seen from that far end of the world.

What is safeguards?

Safeguards is a guarantee provided to other countries by those countries with potential capabilities or knowledge, that they do not intend to join the proliferators club, unless they are forced to.

To call safeguards a system of control is just an euphemism. The safeguards system cannot, and should not, restrain, govern or regulate the actions of a country in the nuclear field. It can only check that the commitment offered is being fulfilled. The biggest mistake that can be made is trying to use the safeguards system to restrain the nuclear activities in a country. This was never its purpose.

Why there are safeguards?

It is quite evident that nobody will offer such commitment for shear pleasure, to enjoy its inner good. Unfortunately, human nature seldom acts like that.

Safeguards, as a guarantee, is offered because it has been requested. Suppliers, years ago, requested such guarantee in reciprocity for allowing free exchange of goods and knowledge, and so happended for many years. Now, things are not any more like that, and Article IV of NPT is not honoured any longer by the suppliers.

This new changed situation provokes a couple of meditations:

1) If there is no access to the required goods or knowledge, nothing justifies providing guarantees on their own developments any more; i.e. no safeguards can be required, no safeguards will be provided.

2) Impairing the free flow of goods and knowledge will make the safeguards system meaningless, will estimulate uncontrollable independent development, will promote distrust, fear and intimidation. And for sure, it can increase proliferation.

Some conclusions can be drawn from here. Proliferation can occur when one has the means and the state of mind. Apparently there are two possible courses to stop proliferation:

1) It can be tried lessening the pressures or the motivations that steer a person, a country, to that state of mind. If you can defuse the state of mind, proliferation will be stopped.

2) It can be tried denying the means. History proves that, as far as the pressures or motivations remain in action, ways will be found to provide for the means being denied. A policy of denial will never stop proliferation.

3) If all you are aiming at is buying time with a policy of denial, such a policy can misfire. Policies of denial are nothing new in history, and we already know that their application have promoted more wars than they were able to avert.

Therefore, we are left with only one real choice to stop proliferation: to defuse the state of mind conducive to proliferation.

How can we lessen pressures on those that feel endangered, how to provide the guarantees they require to let them disarm? It is hard for me to find a straight answer. All I can say is that anything done to promote peace and security, to promote general disarmament, will help to stop this type of nuclear proliferation.

Whow can we lessen the motivations is a different matter. Here the possibilities are in the hands of those who hold the weapons. As far as the possession of weapons keeps being a symbol of distinction, privilege and despotism, it is quite evident that very little will be achieved.

But actions can be taken to relinquish some of these privileges and end that despotic behaviour. A good, honest start to tackle the obligations under Art.VI of NPT will help. Extending the guarantees under Protocol II of the Tlatelolco Treaty to other regions of the world, maybe to all non-weapon countries, will soothe many fears and some ambitions. All one sided decisions impairing the free flow of goods and knowledge should be avoided. What mutual guarantees are going to be provided should be agreed between or among all interested parties.

Nuclear weapons are not the concern of a few, but a worry for everybody. As much damage to the cause of non proliferation has been produced by the nuclear explosion in India, as by unilateral decisions taken by Australia, Canada, USA and the so called London Club, with its infamous list of so called "sensitive" equipment and technology.

On top of this all, we cannot ignore the close interplay of commercial interests and political aims. This does not make any easier the holy cause of non-proliferation. It is not possible to disregard the strong commercial advantages that a policy trying to impose the one-through cycle, non-plutonium use, has for countries like Australia, Canada, USA or Holland, suppliers of uranium and enrichment services.

It is quite evident that this policy is not shared by the big industrial countries in Europe. What is quite understandable, because they have other interests. This does not mean they are free of blame, because they are also members of the so called London Club. Probably the best example of how holy purposes and commercial interests can be mixed, or messed up, are the so called London Club guidelines.

The whole listing under reactors and equipment has no proliferation value whatsoever, but are most important items in the nuclear power trade on which suppliers are advised to "... exercise restrain in the transfer of sensitive facilities, technology...".

Brandishing together heavy water facilities or technology with reprocessing and enrichment facilities or technology, makes a mockery of the non-proliferation purposes of the document. It really aims at preventing the development and use of a type of nuclear power reactor more efficient and competitive, that can not be choked by the monopoly on enrichment.

Under the disguise of trying to restrain the spread of what have been called "sensitive technologies" it is all too evident the intention to use the Club to hold the trade in their hands as far as they can.

We recognize that the picture from that end of the world does not look very promissing for a country that is making its way up to self sufficiency in the nuclear power field, particularly in the nuclear fuel cycle, through this maze of holy purposes, shrewd commercial interests and plain blindness.

We are looking for answers to some fundamental questions:

1) Will developing nations be willing to trust their future to a closed group of suppliers and depart from their policies of energy self sufficiency?

2) Will suppliers be willing to trust the guaranties (i.e.safeguards) provided by the consumers and depart from their policies of denial?

3) Will weapon countries be willing to endorse a policy of self denial and depart from their privileges, to dissuade other countries from becoming members of the weapons club?

It is hard to guess the answers, I only know one of them. But, it is quite evident that three "no" are equivalent to a complete deadlock, where all sides will be hurt. No trust, no trade, no development, more fear, more weapons, will be the outcome. To make any progress towards peace and understanding we need at least one "yes". Two "yes" will be great, three may be too much! Everyone can pick up where he wants to see the "yes" answers in this little enquire.

To end this short account of our views, we are aware of a line of thinking implicit in the NPT discriminatory approach, that rates a nuclear weapon as a dangerous item only when in the hands of some governments.

We do not believe so. It is only a matter of appraisal or preference if one feels more or less secure when the weapons are here or there. Nuclear weapons are always dangerous, whichever the government holding them.

It is clear to us that something needs to be done if we want to avert a complete disruption of international trade and relations in the nuclear field, maybe a generalized confrontation, that indubitably will stimulate the proliferation we are trying to stop. In our views the burden is on the weapon countries and those suppliers who have followed their line so far.

The weapon countries, because they are the only ones who can take the glamour out of the nuclear weapons, and the ones that can assure peace and security to those who feel their survival endangered.

The suppliers, because it is in their hands to restore trust in international nuclear trade and relations. They are the ones who have broken the agreements in the past, they are the ones who should make the first move to rebuild the confidence they have lost.

It is in their hands to reopen the road to a brighter future for all mankind. Can we trust them, or not?

SAFEGUARDING PLUTONIUM IN THE GLOBAL ENERGY ECONOMY OF THE FUTURE: PROBLEMS AND PROSPECTS

by Sigvard Eklund

Nuclear opponents who as is well known are mainly to be found in the industrialized western or free market countries have shifted the focus of their criticism from time to time. Just now, they are, of course, concentrated on safety questions, but previously we had experienced a long period where they aired their concern about the connection between nuclear power and proliferation of nuclear weapons.

Let me recall that since 1970 we have a Non-Proliferation Treaty, the NPT, to which 105 non-nuclear-weapon states and three nuclear-weapon states are parties. By adhering to the Treaty, the non-nuclear-weapon states (NNWS) have undertaken not to develop or acquire nuclear explosives of any kind. It is the task of the IAEA to ensure through the application of its safeguards system that the NNWS honour their obligations according to the Treaty. The political will expressed by the NNWS in acceding to the NPT is the essential base for our actions to prevent further proliferation of nuclear weapons. The IAEA safeguards system is geared towards the timely detection of diversion of significant quantities of nuclear material for nuclear explosives or unknown purposes. The safeguards system can be said to establish a kind of mechanism for a mutual control; but here I must again emphasize that the essential factor is the expression of the political will which the NNWS have demonstrated through the universalization of the NPT, and not whether the system of control is more or less technically sophisticated. We know that there are no technical fixes which can achieve a 100% control.

In the meantime, we have seen a decreasing willingness on the part side of the general public to accept nuclear power. Thus it is by no means rhetorical to ask how much nuclear power there would be in the next five to ten years from which proliferation could take place. I am a strong believer in nuclear energy, but we may now face a moratorium for a few years in some countries.

If we, nevertheless, assume that an expansion of plutonium appears inevitable in the future, it is apparent that certain problems and specific perspectives will arise. Accordingly, I will now turn to the problem of safeguarding plutonium: a material with direct use in both power generation and nuclear weapons. As we know, there are two important problems associated with its use. These are the non-proliferation of nuclear weapons and the security of the supply of materials for the nuclear industry as an essential energy source.

For more than thirty years, the attention of the world has focused mainly on the first of these two dimensions, namely, on ways and means of preventing further proliferation of nuclear weapons.

It is important to recall that the five powers who have acquired a nuclear weapons capacity have all done so through facilities dedicated to this end and not through civil power programmes. The greatest proliferation risk is that of weapons development through clandestine facilities assigned to this purpose – whether for the separation of plutonium or the high-enrichment of uranium. This danger must be countered by political means, rather than by controls on the civil fuel cycle.

I have mentioned highly enriched uranium. In talking about the possible uses of plutonium, one must be aware that enriched uranium is an equally effective material for nuclear explosives. In considering proliferation problems one must, therefore, give equal attention to enrichment and plutonium separation as sources of weapons-usable material.

Plutonium has the quality unique among nuclear fuels of renewing itself, and it would be unrealistic not to accept that fuel cycles using plutonium must and will be developed. We, therefore, have to find a way of controlling the use of plutonium so that the legitimate aspirations of states to develop fuel cycles using it, particularly in fast reactors, can be realised without unnecessary impediments, while at the same time reassuring the world community against a further spread of plutonium-based weapons.

In this connection we have to recognize the second implication of the plutonium question, which also applies to other nuclear materials and equipment: the security of supply for the nuclear industry. Solutions must be acceptable to all the states concerned, whether suppliers, reprocessors or users of nuclear materials.

Some of the measures taken by states recently in implementing their non-proliferation policies have led to difficulties and fears concerning the assured and stable supply of materials and equipment – and, hence, to fears about the fundamental security of energy supplies. This has added to the prevailing atmosphere of doubt, uncertainty and mutual mistrust.

In the Agency, our safeguards programme is designed to detect the diversion of nuclear materials. Recently there have been three developments specifically related to plutonium. The Agency's programmes:

- to develop adequate safeguards for reprocessing plants;
- to improve the physical protection of nuclear material; and
- to develop a system of international plutonium storage.

Safeguarding plutonium is not a single, isolated issue. Plutonium is only one of the nuclear materials to which safeguards apply. It is a man-made chemical element which in the nuclear energy industry is generated within reactor fuel elements at the same time as uranium fission (and the release of energy) occurs. This greatly simplifies the safeguarding process which at this stage essentially concentrates on fuel element identification and counting.

It is in the next stage, reprocessing, that safeguards face their greatest challenge. Here the fuel elements lose their identity, are dissolved and yield the remaining uranium and produced plutonium, leaving the fission products to be disposed of as waste.

Reprocessing plants are very significant from the point of view of safeguards because the separate plutonium which they produce could be used for nuclear explosives.

The Agency is accumulating further experience in applying safeguards to reprocessing plants. It has conducted safeguards exercises at plants in the USA, Belgium and Italy. The basic method for verifying that all safeguarded nuclear material is accounted for is material accountancy: this includes such techniques as measurement and sampling and is complemented by constantly improving methods of containment and surveillance. However, for various technical and operational reasons, some of which I have already mentioned, this may not be sufficient in the case of the large reprocessing plants to be safeguarded in the 1990s. Attention has, therefore, recently been increasingly focused on additional safeguard measures which would provide on-going, continuous information on the nuclear material being processed in the plant.

Moving on from the operations associated with the process through which plutonium is produced and isolated, relatively little need be said here about the application of international safeguards to storage facilities or storage areas. It is not difficult to surround a storage facility with any desired level of seals, surveillance cameras, motion detectors, radiation detectors, etc., and thereby guarantee to any desired degree of assurance that no nuclear material quantities (above a defined minimum) could leave the storage facility/areas without prompt detection.

While on the one hand it would be wrong to conclude that there are no safeguards problems involved in the recovery of plutonium from fuel elements, it would be equally wrong to claim that reprocessing plants cannot be effectively safeguarded. A vigorous programme of research and development is underway; three efforts in particular require mention, namely, the programm of technical support for international safeguards undertaken by the Federal Republic of Germany, the United States of America and the quadripartite (Japan-USA-France-IAEA) TASTEX programme to develop advanced safeguards technology in connection with the Japanese Tokai reprocessing facility.

In addition, in June 1978 the IAEA held an Advisory Group Meeting on Safeguards for Reprocessing Facilities. The primary recommendation of that group was that the IAEA should organize a co-ordinated research and development programme. To that end an International Working Group will assist the Agency in conducting a comprehensive study of safeguards systems and techniques for the existing smaller reprocessing facilities.

While safeguards are designed to verify that nuclear material, inclusive of plutonium, is adequately accounted for and not diverted, the physical protection of such material with a view to preventing its seizure or theft by individuals or subnational groups is also of great concern. While certain safeguards measures and physical protection measures may in practice overlap, the responsibility for physical security of nuclear material rests with the states concerned.

For a number of years the IAEA has been concerned with the development of recommendations to member states for appropriate protection guidelines for plutonium and other nuclear materials. These recommendations were published in an IAEA document in 1975 and are now recognized as accepted international norms in that field.

There has been a growing awareness that a number of problems relating to the adequate protection of nuclear materials require further action; preparatory work is underway for the negotiation of an international convention on the physical protection of nuclear material under Agency auspices. The last session of the conference took place in June 1979 and passed that final agreement. The convention not only provides for mandatory application of protection standards to nuclear materials in international transport but also for the prosecution and punishment of individuals engaged in acts of theft or sabotage involving such material.

The concept of international plutonium storage was incorporated into the Statute of the Agency (Article XII. A. 5) when it was founded. Its aim is the international physical control of plutonium at the most sensitive fuel cycle stage of all – the storage and handling of plutonium in separated form after reprocessing and before use.

International plutonium storage would reinforce and complement safeguards on reactors, reprocessing plants and fuel fabrication. Placing of separated plutonium in internationally controlled storage, could assuage the fears of those who claim that safeguards alone cannot offer sufficient reassurance that plutonium stored in significant quantities, for long periods and in a form readily usable form for weapons is adequate protection against clandestine diversion.

Whatever the outcome of the present international focus on non-proliferation, particularly in INFCE, the fact remains that plutonium has been separated for many years in the civil fuel cycle and that significant stocks of it already exist, albeit in a limited number of states at this stage. As states work towards fast reactor programmes, the separation of plutonium will inevitably not be matched by immediate requirements in at least the next twenty or thirty years. It will be stockpiled, either under national or international auspices.

Information supplied by states (excluding those with centrally planned economies) to INFCE – which is the most up-to-date data we have – indicates that by 1990 a further 126 tons of plutonium will have been separated and by the year 2000, this figure will have increased to over 400 tons. How much of this projected separation will be in stock rather than in use at those dates is speculative, but the Working Group 4 data suggest at least 25% at both dates.

Therefore, the Agency has been studying the possibility of introducing a system of international plutonium storage in accordance with Article XII. A. 5 of our

Statute. A study on this was circulated to all member states in July 1978, which aroused considerable interest. As a result, in December 1978 a Working Group was convened to prepare a detailed plan. The group consists of experts from all member states wishing to take part in the exercise and is attended by representatives of twenty-four countries.

It was made clear at the beginning that to be generally acceptable any plan would of necessity be non-discriminatory and must find a realistic balance between non-proliferation objectives and non-interference with national energy programmes.

On this basis, the group has made good progress and is approaching agreement on principles and procedures for the deposit and release of plutonium and on the practical aspects of a plan. As regards the practical aspects, it would seem likely that the consensus will be to locate internationally controlled stores at all reprocessing plants in states participating in a system of international plutonium storage – and probably at major fuel fabrication plants. Release of plutonium would not be permitted except with the approval of central controlling machinery, which would make decisions according to the agreed principles and procedures.

The group met for the third time in November 1979. It will continue its work in 1980. So far progress has been very encouraging and – if its work results in the establishment of a concrete plan – this would be a major contribution towards both the solution of some of the political constraints preventing much-needed developments in the nuclear industry and to the world non-proliferation regime.

SAFEGUARDS UNDER THE NON-PROLIFERATION TREATY

by D. A. V. Fischer, Assistant Director General for External Relations, International Atomic Energy Agency (IAEA)

Introduction

The Treaty on the Non-Proliferation of Nuclear Weapons entered into force on 5 March 1970. It thus took 25 years after Hiroshima and Nagasaki to launch a treaty explicitly designed to stop the spread of nuclear weapons. However, the Treaty drew heavily on the demonstrated capacity of the International Atomic Energy Agency (IAEA), then already 13 years old, to devise and apply international safeguards to prevent the diversion of nuclear materials to warlike use.

By March 1970, five States had already acquired and demonstrated their capacity to make and use nuclear explosives. Since then, one further nation has detonated a single nuclear explosive, and there have been reports that two or three others have acquired or are building unsafeguarded nuclear plants that can produce nuclear explosive material—plutonium or highly enriched uranium.

The five "nuclear-weapon States" have continued, with little abatement, to test nuclear weapons; underground, in the case of the three nuclear-weapon States that are parties to the partial test-ban or Moscow Treaty of August 1963 and in other environments as well in the case of the remaining two countries.[1]

Thus, despite the stated intention of the non-proliferation Treaty to bring to an end the further spread of nuclear weapons and to achieve "the discontinuance of all test explosions of nuclear weapons", there has been some further spread of nuclear explosive capacity, and testing has continued.

Must we therefore conclude that the Treaty has been a failure?

Far from it. In the 12 years since the Treaty was opened for signature, 114 countries have ratified it, including three of the five

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[1] France, in 1974, announced that it would continue only its programme of underground testing.

D. A. V. Fischer. Safeguards under the Non-Proliferation Treaty; in Disarmament, a periodic review by the United Nations, Vol. 3, No. 2, July, 1980, pp. 35-41. Reprinted with permission by the United Nations.

nuclear-weapon States. A fourth nuclear-weapon State has indicated that it will behave as if it were a party to the Treaty, and has adhered to this declaration.

The non-nuclear weapon States that have joined the Treaty include almost every industrial country in this category. In addition, nearly 80 developing countries have joined the Treaty. Geographically, the Treaty encompasses all the countries of North America, all the countries of Eastern Europe except Albania, all the non-nuclear-weapon States of Western Europe except Spain, the broad band of countries stretching down from Japan through South-East Asia to Australia and New Zealand, more than half of the countries of Africa and all but four of the Latin American States that have any nuclear facilities.[2]

A powerful supplement to the Treaty has been given by the Agency for the Prevention of Nuclear Weapons in Latin America (OPANAL) set up under the Treaty of Tlatelolco, which pre-dates by two years the non-proliferation Treaty, has similar aims, and is being fully applied in all but six of the States of Latin America.

In accepting the non-proliferation Treaty or in fully applying the Treaty of Tlatelolco all these countries have abjured nuclear weapons and have agreed to submit their entire nuclear industry to the safeguards of the International Atomic Energy Agency to verify this commitment. For this purpose, each country is required to conclude a comprehensive agreement with the Agency for the purpose of bringing all nuclear material in all its peaceful nuclear activities under IAEA safeguards.[3] With one minor exception, every country in this group that has any significant nuclear activity has concluded the safeguards agreement with IAEA.

A policy decision, enshrined in treaty obligations, to prevent the further spread of nuclear armaments and to accept international safeguards for this purpose has thus been accepted by nearly all the industrial countries of the world and a great majority of developing countries.

This was by no means the case in the early 1970s. The non-nuclear-weapon States of the Common Market only ratified the Treaty in May 1975 after lengthy national debate and after the conclusion of the Safeguards Agreement between IAEA, EURATOM

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[2] However, States not parties to the Treaty include some of the largest and most industrially advanced countries in the region.

[3] The non-proliferation Treaty does not proscribe the use of nuclear material for non-explosive military purposes, e.g. as fuel for submarine engines. However, no non-nuclear-weapon State party to the Treaty has so far availed itself of this option.

(European Atomic Energy Community) and the States concerned. Japanese ratification came later still, in 1976.

The process of accepting the Treaty has by no means come to an end. During 1979, five further States joined it, namely, Bangladesh, Cape Verde, Indonesia, Sri Lanka and Tuvalu; Barbados and Turkey became parties early in 1980.

Besides those countries that have formally accepted the non-proliferation Treaty or are fully applying the Tlatelolco Treaty, there are a half a dozen countries in which "de facto full-scope" safeguards exist. In other words, IAEA safeguards are being applied under a mosaic of bilateral agreements to all known nuclear facilities in the countries concerned. They include Argentina, Brazil, Chile, the Democratic People's Republic of Korea, Turkey and, at least at present, Pakistan.

The potential for a further spread of nuclear explosive capacity is, of course, strongest where there is an unsafeguarded nuclear plant capable of producing significant quantities of plutonium or highly enriched uranium. This situation exists in India, which detonated a nuclear explosive in 1974, as well as in Israel and South Africa, and it has also been reported that Pakistan is building an unsafeguarded enrichment plant. It has been rightly said that where the non-proliferation Treaty and IAEA safeguards end, the danger of proliferation begins.

If we are to put a complete stop to the further spread of nuclear weapons, the first objective must be the universal acceptance, at least in practice, of the non-proliferation régime, in other words, the application of IAEA safeguards to all nuclear material in all plants in all non-nuclear-weapon States. With the exceptions mentioned, we are not far from this goal.

The second objective must be to turn such practical acceptance into legally binding obligations by universal ratification of the non-proliferation Treaty or the full application of the Tlatelolco Treaty. This goal is more remote.

Many States have pointed out that achievement of either goal will depend, at least partly, on the actions of the nuclear-weapon States themselves in fulfilling the obligations they have accepted under the Treaty. In particular, an effective and enduring nuclear test-ban treaty would halt the 50 or more tests carried out each year by the nuclear-weapon States, and thus put an effective brake on vertical as well as horizontal proliferation. It would also do much to meet the criticism that the non-proliferation Treaty perpetuates discrimination between the nuclear and non-nuclear-weapon Powers.

Safeguards

Sixty-nine countries parties to the non-proliferation Treaty have now concluded the agreement placing all their nuclear activities under the IAEA/non-proliferation Treaty safeguards systems.[4]

This has, of course, entailed a massive expansion of the Agency's safeguarding operations. In the 10 years since the entry into force of the Treaty, the safeguards budget has grown from US$ 1 million (1970) to more than US$ 19 million (1980).

The operation of the Treaty has also brought about changes in the approach to safeguards. Prior to 1970, safeguards were being applied chiefly to isolated individual reactors. Today, they cover the entire fuel cycles of major industrial countries encompassing every type of nuclear activity from the fabrication of fuel through its enrichment, use in the reactor, reprocessing and eventual storage or disposal.

In 1970, in anticipation of this expanded role, the Agency developed a standard non-proliferation Treaty safeguards agreement. The underlying concept was to follow the flow of nuclear material through the fuel cycle. As a result, it is possible today, at the headquarters of IAEA in Vienna, to plot and follow the movement of nuclear material through the nuclear arteries of all safeguarded countries and across international boundaries. This is a complex operation which makes use of the most advanced computer technology. It is based on routine reports which each plant handling safeguarded material is required to send each month to the Agency. A staff of almost 150 inspectors plays an essential role in verifying that the reports tally with the records that every plant operator is required to keep and that the accounting calculations tally with the physical facts. This is done whenever the operator checks his stock (inventory verification) under the supervision of the Agency's inspectors.

Applying safeguards at the most common type of nuclear power reactor (the light-water reactor) in which one third of the 100-ton fuel core is usually changed only once a year in an operation that may take several days, is a relatively simple matter, and the possibilities of diverting nuclear material for making nuclear explosives are very limited. In between fuel core changes, it is only necessary to verify at, for instance, three-monthly intervals that there has been no unreported removal of spent fuel from the storage pond or from the reactor itself. For this purpose, the IAEA is installing tamper-resistant cameras and, more recently, video-recorders that take half-hourly pictures of the sensitive parts of the plant. By checking these pictures every three months, the inspector can see whether there has been any unreported removal of fuel.

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[4] These agreements cover all except a couple of small research reactors which are in the territory of recent adherents to the Treaty and which are already under IAEA safeguards by virtue of earlier safeguards agreements outside the framework of the non-proliferation Treaty.

At the other end of the spectrum, safeguards on large reprocessing plants and enrichment plants are complex. In these types of plants, safeguarded plutonium or other readily usable nuclear explosive material may be present in large quantities, and it is essential that any diversion should be promptly detected. The Agency and several of its member States are putting in much effort to develop the equipment needed to safeguard these and other types of nuclear facilities—equipment such as sensors—which will record all movements of material, transportable counters which enable the inspector to determine on the spot the quantity of plutonium in a fuel rod, means for counting the number of fuel bundles coming in and out of natural uranium reactors where there is a constant movement of fuel throughout the year, and other sensitive recording, measuring, counting and analytical instruments. Not only is the effectiveness of safeguards increased in this way, but it also becomes possible to reduce the human input needed to verify nuclear activities.

It is also important to encourage designers and constructors of nuclear plants to bear in mind the need for making international safeguards as effective and easy to apply as possible. Some of the problems encountered today could have been avoided by safeguards oriented design.

One of the main developments in safeguards since 1975 has been the institutionalized co-operation between IAEA and the already established safeguards machinery of the Common Market countries—EURATOM. It took several years to reach agreement on how to mesh together the aims and work of IAEA and the Community in the area of safeguards so as to avoid unnecessary duplication and yet enable each organization independently to reach its own conclusions about the effectiveness of its work. This task is now concluded, partly by the use of joint teams of inspectors from the two organizations in all the most sensitive facilities.

It can be said today that the application of safeguards under the non-proliferation Treaty is tending to become more and more of a routine quasi-industrial operation with well-defined and well-understood objectives based increasingly on precise numerical operations which permit IAEA to reach "quantified" conclusions, i.e. conclusions based entirely upon mathematical calculations rather than on the inspector's own judgement, however objective that may be. Nevertheless, in an increasingly complex operation of this kind, it will never be possible to eliminate entirely the element of judgement.

Today, more than 86 per cent of the nuclear plants in all the non-nuclear-weapon States are under non-proliferation Treaty safeguards and more than 11 per cent under safeguards outside the framework of the Treaty. Moreover, the safeguarded plant includes almost all the more complex and difficult facilities in these countries. Universalization of the Treaty régime to include those countries that have not yet accepted the Treaty would, therefore, add relatively little to the technical safeguards responsibilities of the Agency. In fact, in most cases it would merely represent a transition from non-Treaty to Treaty safeguards. The few unsafeguarded plants, although potentially of great proliferation significance, would entail only a very minor additional safeguards effort.

The future growth and development of the operation, therefore, depends first on expanding its resources so as to be able fully to achieve the targets of effective safeguards on existing plants and secondly, on the future development of nuclear energy in the countries parties to the Treaty themselves. The application of safeguards in those three nuclear-weapon States that have voluntarily offered to place all or some of their nuclear facilities under IAEA safeguards (United Kingdom, United States and France) will also place some further demands on the system but, in practice, the Agency will concentrate its verification efforts in a highly selective manner and on plants of the most advanced design or special significance in international commerce in these countries.

The growth of the operation since 1970 may be illustrated in other ways. In 1970, the total amount of plutonium in all forms under safeguards was 770 kg; by 1975, it had risen to 17 tons, and by the end of 1979 to 68 tons. There was a similar growth in other safeguarded nuclear material (enriched uranium and natural uranium). The number of power reactors under safeguards in 1970 was 9; by the end of 1979, the figure had risen to 119.

IAEA has also established an international group to develop arrangements for placing separated plutonium—which probably constitutes the gravest proliferation potential in the technical sense—in IAEA custody in all countries that will take part in the scheme. The plutonium would only be released in accordance with rules and principles agreed to by the countries concerned. Safeguards would of course follow the plutonium and its end use would be checked. This safeguards measure is foreseen in the IAEA Statute but remained a dead letter until quite recently.

Conclusion

In conclusion, it is fair to say that although safeguards represent a novel form of international and, indeed, of human endeavour, safeguards techniques and capacities have evolved rapidly, and the remaining technical shortcomings of safeguards do not today represent a significant impediment to an effective international non-proliferation régime. The barriers that still stand in the way of such a régime are predominantly political and not technical in character.

Amory B. and L. Hunter Lovins, Energy/War: Breaking the Nuclear Link

(Excerpt)

Chapter Three

Disguises and "Safeguards"

Can the stark conclusion of the preceding chapter be weakened, and the unexpectedly intimate link between reactors and bombs be severed, by conceivable "safeguards" on nuclear materials?

Great ingenuity and care have been devoted to developing ways to measure fissionable material so as to detect (preferably with timely warning) illicit removal or, in the absence of such an alarm signal, to confirm continued presence. Unfortunately, physically conceivable ways of measuring plutonium[57] must be after-the-fact and statistically imprecise: so imprecise that they cannot, even in principle, provide reasonable assurance that many bombs' worth of plutonium per year are not being removed from, say, a good-sized reprocessing plant. (Broadly similar problems arise with other kinds of facilities.) In practice, materials accounting methods are readily deceivable in many subtle ways which defy detection[58]. Presently available methods are much worse than the ideal, and historically used methods worse still: the statistical "noise" of US measurements alone has already accumulated to tons of strategic material, including some strategic quantities officially suspected of being physically missing. (As is the way of statistical measurements, however, it is impossible to say for sure whether they are missing or not.) World nuclear power over the next two decades could produce over two thousand tons of plutonium. A mere half of one percent of this figure—about half of the ideal or a quarter of the currently typical imprecision of inventory in spent fuel entering a reprocessing plant—would suffice to make thousands of bombs.

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[57] Though broadly similar problems arise with all fissionable materials, plutonium is particularly hard to measure precisely because it is generally in an impure form, subject to both loss and gain by radioactive decay, highly toxic, very complex and fickle in chemistry, self-heating, and prone to stick to or to migrate out of containers. The nuclear properties normally used for assay are highly sensitive to isotopic composition, impurities, and interfering materials.

[58] D. M. Rosenbaum *et al.*, "A Special Safeguards Study," *Congressional Record 120*:S6621-30 (30 April 1974); GIR[29], Chapter 4. The more complex the plant and its accountancy methods, the more subtly the inspectors can be deceived: the plant, for example, may not be built according to the blueprints, standard samples can be biased, interfering materials added, instruments doctored, computers reprogrammed, etc. Such vulnerabilities are surveyed by Lawrence Berkeley Laboratory, *A Study of Nuclear Material Accounting*, NUREG-0290, 3 vols., USNRC, 1977. See also R. J. Smith, *Science 209*:250–52 (1980).

Because materials accounting is so fuzzy and *post hoc*, political arrangements for safeguards must rely primarily on physical security measures to limit access to materials and to deter or prevent their removal (or, if they are removed anyhow, to recover them). These measures must forestall well-equipped groups, perhaps including senior insiders acting in concert with the host government or a faction of it. History shows that any physical security measures can be overcome by sufficiently determined thieves or embezzlers, and careful analyses confirm that even modestly effective measures covering key plants and transport networks would be costly, fallible, and personally and socially intrusive.[59] In the Federal Republic of Germany, for example, they would exceed the authority of the Atomic Energy Act; amending it to permit them would be unconstitutional; and amending the Constitution to permit them would conflict with human-rights instruments to which the Federal Republic is a party.[60]

The institutional arrangements which rely on these inherently inadequate accounting and security measures—the latter being administered entirely by national governments—are woven around the International Atomic Energy Agency (IAEA), the Non-Proliferation Treaty (NPT), the EURATOM and Tlatelolco Treaties, and bilateral agreements. Though these instruments are a considerable achievement, they have well-known and collectively fatal flaws, reflected in many supplier governments' insistence on stricter (though still wholly inadequate) supplementary constraints through new bilateral arrangements or the London Suppliers' Group. These flaws include:

- Non-adherence of about fifty countries including half the world's population, including two of the five acknowledged weapons states (France, China), all three suspected ones (India, Israel, South Africa), and all major developing countries except Iran and Mexico (in particular, Argentina, Brazil, Egypt, Pakistan, and Spain).

[59] See for example Justice (UK Section, International Commission of Jurists), "Plutonium and Liberty," London, 1978 (fully accepted by the Parker report[42]); J. H. Barton, "Intensified Nuclear Safeguards and Civil Liberties," report to USNRC, Stanford Law School, 21 October 1975; R. Ayres, *Harvard Civil Rights–Civil Liberties Law Review 10*:369 (1975); R. Grove-White and M. Flood, "Nuclear Prospects," FOE[29]/CPRE/NCCC, London, 1976; Royal Commission on Environmental Pollution (London), *Sixth Report*, Cmnd. 6618, HMSO, 1976 (e.g., ¶¶185–6, 321, 325, 331–3, 505–7).

[60] P. Sieghart, Chapter 4.4 in GIR, *op. cit.*[29]

- Freedom to renounce.
- No prohibition on designing bombs or building and testing their non-nuclear components[61].
- Unsafeguarded duplicate facilities.
- Inadequate inspection staff, facilities, and morale.
- Virtual absence of developing-country nationals in key IAEA safeguards posts.
- High detection thresholds[62].
- Freedom of host governments to deceive, reject, hinder, or intimidate inspectors or to restrict their access (especially their unannounced access), often by such simple means as saying that a certain area cannot be visited because of a minor spill of radioactive material.
- Unknown effectiveness owing to confidentiality[63].
- Ambiguous agreements[64].
- Unsupported presumption of innocent explanations.

This last point deserves special emphasis. IAEA findings that no significant diversions have occurred are judgmental, not objectively supportable even according to the Agency's generous technical criteria. Inspections must rely on the good faith of precisely the countries that have the least incentive to exhibit it, and

[61] The non-nuclear components are in general the most difficult to develop and their designs the most secret aspect of weapons technology. Further, all agreements appear to leave the term "nuclear explosive device" and allied terms undefined. Can it mean a finished bomb lacking only a rapidly insertible key component or data—in which case Permissive Action Link-equipped US bombs are arguably not bombs? Nobody knows (though by this semantic ruse the US claims today not to be manufacturing neutron bombs—only their readily assembliable components). The US has insisted that laser-fusion target pellets, including those using fissionable materials, are not bombs.

[62] As noted in ref. 37, the IAEA's 8-kg design basis for detecting plutonium diversions[40] is several times the quantity needed to make a bomb.

[63] The IAEA Statute contains secrecy provisions which the Agency construes as broadly as possible—even to refusing to reveal which countries have how much of what kind of accounted-for nuclear materials. Acknowledged inadequacies[40] of accounting occurred in twelve of forty-one states inspected in 1976, but the IAEA declines to say which states. As a result, the USNRC Division of Nuclear Materials and Security and the US General Accounting Office (ID-75-65, 3 July 1975, based on earlier problems) have found that the adequacy of IAEA safeguards cannot be independently judged. Confidentiality rules are also "being used as an alibi for remaining ignorant about the inadequacies" of IAEA safeguards.[13]

[64] Iklé (*op. cit.*,[13] xiv) remarks that "some Washington bureaucrats would bend over backwards to interpret ambiguities (which they themselves may have written into the agreements) so as to exonerate the foreign government that had defied the intent of Congress."

conversely, restrictions and provisions for strict compliance are "most likely to be accepted where they are least needed."[65] The IAEA is a UN bureaucracy anxious to make no waves, give no false alarms, and promote nuclear power[66]. If an alert, incorruptible, omnipresent inspector instantly detected a big, blatant diversion and succeeded in getting the news instantly from his field post to the Inspector-General, thence to the Director-General and the Board of Governors, thence to the Security Council (subject to veto)—would the exhaustive re-examinations on which they would all doubtless insist even have been officially notified in all the UN languages before a bomb went off?

In fact, the record so far suggests matters would probably never get that far. The IAEA has *already* detected diversions of quantities too small for bombs and has privately decided that these did not justify even notifying the supplier states concerned.[67] IAEA inspectors "have found many [suspicious] indications and acts . . . , but the IAEA has never taken action on any of them. This will probably continue to be true."[68]

Nor should this come as a surprise. All the resources of the US Government, in more than a decade of repeated investigations, were unable to determine whether suspected plutonium thefts at the Numec plant in Apollo, Pennsylvania had in fact occurred. Large HEU losses over many years at an Erwin, Tennessee plant crucial to US naval reactor fuel supply led in 1979 to relaxed accounting standards that would make the losses look "acceptable".[69] How, then, could an intergovernmental bureaucracy, with all its tensions and constraints, be expected to investigate suspected thefts in and perhaps by a recalcitrant foreign country?

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[65] R. W. Fox and M. Willrich, "International Custody of Plutonium Stocks," International Consultative Group on Nuclear Energy (Rockefeller Foundation, NY, and Royal Institute of International Affairs, London), November 1978.

[66] The IAEA Statute mandates the promotion of nuclear power, which the current Director-General, a plutonium enthusiast, does not even believe is linked to proliferation—a "risk which may never materialize" and which he ranks as less important than propagating fast breeder reactors (see his 8 December 1977 address, reprinted in *Reader*[2c] 127–29).

[67] R. Rometsch, remarks in panel discussion before the Institute of Nuclear Materials Management, 20 June 1975, reprinted at 1214–17, US Senate Committee on Government Operations, *Hearings on the Export Reorganization Act of 1976*, USGPO 71-259, 1976.

[68] D. M. Rosenbaum, *International Security 1*(3):140 (Winter 1977).

[69] This "solution," accompanied by improved physical security measures, succeeded an earlier policy, where losses were outside acceptable statistical limits, of repeating and averaging the measurements until losses came within those limits—like losing a game and then deciding on best two out of three.

Finally, the momentum and bureaucratic entrenchment of nuclear programs generally prevent effective sanctions against even an obvious, sharp violation, let alone a dimly suspected, creeping one. Such action as is rarely taken—as in the skilled demolition of an Iraq-bound French reactor by unknown saboteurs in 1979—is in default of official responses but can hardly substitute for them. The international community has never been adept at sanctions generally (Rhodesia, Chile, Namibia, Afghanistan), and the nuclear record is even worse. The US failure to take effective measures against India, Israel, or Pakistan illustrates the low priority that is likely to be mustered in practice, and may even increase the value of a putative bomb program as a bargaining chip. The breach of EURATOM safeguards by the theft of an entire 200-ton shipload of natural uranium in 1968—presumably bound for Israel's unsafeguarded Dimona reactor, which France had supplied in return for heavy-water technology—was detected within three months but kept secret by the governments concerned for nearly ten years. All the relevant governments knew about India's bomb program a decade before the 1974 test: Canadian scientists, for example, had warned their government that Indian trainees in plutonium metallurgy around 1963-65 were displaying untoward interest in purely military subjects. But this foreknowledge evoked only diplomatic murmurs, and the actual test, as Albert Wohlstetter remarks, "inspired only ingenious apologies" from the US State Department—anxious to conceal the US contribution of heavy water—and a congratulatory telegram from the Chairman of the French Atomic Energy Commission. As front pages in 1979 heralded the Pakistani bomb program, Pakistan was being unanimously elected to the IAEA's Board of Governors. As suspicions grew that Iraq (a party to the NPT) was pressing France for a promised HEU shipment partly out of military motivations, an Iraqi was chairing the 1980 NPT Review Conference.

In sum, present safeguards—consisting in essence of infrequent (quarterly or less) inventories that may belatedly detect statistical indications of large, incompetent diversions from safeguarded facilities in cooperative countries—may be better than nothing if their limitations are clearly understood. But this appears not to be the case among many credulous people for whom an "insouciant lack of realism"[70] and soothing repetition of the word "safeguards" have lulled a sense of danger and

[70] Iklé, *op. cit.*[13]

cloaked dangerous activities in benignity. Indeed, this sense of complacency about transferring larval bombs "under international safeguards"—as if bomb-making had thereby somehow been prevented—may arguably be worse than not having either safeguards or their false sense of security. At first the world was told there was no problem—the IAEA would fix it—and then that there is no solution. Some analysts seem to hold both these views, rationalizing that perhaps proliferation is not so bad anyway. The IAEA's Director-General advocates faith healing:

> After all the ingenuity displayed in the development of nuclear power, we would demonstrate unbelievable incompetence if we were suddenly to lose confidence in our ability to cope with the problem of proliferation.[71].

But if there is a solution, it does not lie in the realm either of a sanguine state of mind or of a strengthened IAEA in a world of sovereign nation-states. We need something more fundamental, built on first principles.

"There is a melancholy lesson," remarked Victor Gilinsky, "in the fact that today we have come almost full circle in our thinking"[72] and returned to the central finding of the percipient Acheson-Lilienthal report of 1946:

> [T]here is no prospect of security against atomic warfare in a system of international agreements to outlaw such weapons controlled *only* by a system which relies on inspection and similar police-like methods. . . . So long as intrinsically dangerous activities may be carried on by nations, rivalries are inevitable and fears are engendered that place so great a pressure upon a system of international enforcement by police methods that no degree of ingenuity or technical competence could possibly hope to cope with them. . . . In short, any system based on outlawing the purely military development of atomic energy and relying solely on inspection for enforcement would at the outset be surrounded by conditions which would destroy the system.[73]

Realistically, during the geological, or rather theological, periods in which bomb materials remain potent, national rivalries, subnational instabilities, and human imperfections[74] will remain stronger than treaties and inspections. Despite thirty-five years of sincere and devoted efforts, the basic contradictions identified by Acheson-Lilienthal ensure that no credible technical or political arrangements can, even in principle, reserve infallibly and perpetually to peaceful uses the enormous amounts of bomb materials that nuclear fuel cycles create.

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[71] S. Eklund, *loc. cit.*[66]

[72] V. Gilinsky, S-14-76,[35] among the best short histories of the problem.

[73] *Op. cit.*[11] The Report is reprinted in US Senate Committee on Government Operations, *Peaceful Nuclear Exports and Weapons Proliferation: A Compendium*, USGPO, 1975.

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[74] A striking short list of examples to spring 1977 appears in the precursor of this book, Chapter 11 of A. B. Lovins, *Soft Energy Paths: Toward a Durable Peace*, Ballinger (Cambridge, MA), 1977, and Harper Colophon (NY), 1979, at 191–92. (See also J. Emschwiller, *Wall Street Journal* 1, 3 September 1980.)

Prospective trends in international safeguards

by Myron B. Kratzer

International safeguards were first proposed in the mid-1950s, and implementation was begun on a modest scale almost 20 years ago. Yet it has only been within the past 10 years that research, development, and systems analysis devoted to the understanding and improvement of safeguards have taken place on a significant scale. Indeed, most of the growth in this now substantial effort has occurred only in the last 5 years.

This new-found dedication to the use of the classic means for attacking technical problems—research and development—has resulted from a number of stimuli, both external and internal to the craft of safeguards itself. A relatively early event, in the late 1960s, was the widely publicized inability to account for a large quantity of highly enriched uranium at a conversion and fabrication plant at Apollo, Pa.

This accountability incident was truly a watershed event—to use an overworked current term—in the evolution of safeguards, since it brought to public attention in a way that could not be ignored a fact long known to safeguards experts: that accounting for nuclear material is, in most cases, more akin to measuring bean stalks than to counting the beans. Additional stimulus was provided by the Nonproliferation Treaty, which dramatically enlarged the role and visibility of safeguards as a source of nonproliferation assurance, and by the Indian nuclear explosion of 1974, which, in the perverse way in which important events so often unfold, tended to discredit the effectiveness of safeguards, even though none was involved.

If any further encouragement to a greatly intensified effort to improve safeguards were needed, these and similar events led to a renewed and at times contentious nonproliferation debate, which went to the very validity of the basic premise that peaceful nuclear activities can be adequately separated from military use by a regime of internationally verified assurances of peaceful use. This debate generated, among other things, the Nuclear Suppliers Group and Guidelines, the U.S. Nonproliferation Policy of 1977 and Nonproliferation Act of 1978, and the International Nuclear Fuel Cycle Evaluation (INFCE), to name only a few.

It is somewhat paradoxical that all of these undertakings reaffirmed the importance of safeguards in the nonproliferation regime at the same time that many were questioning the validity of the basic mission of safeguards, even if they could be made technically infallible, to serve as an adequate barrier against proliferation.

For the safeguards professional, however, whether practitioner or researcher, an even more basic motivation and rationale for the greatly expanded research and development effort than any of these events and development has been the growing realization that safeguards are a technically tough job. To state this is not to suggest that safeguards were ever viewed as a simple task, or that the change in perception has been sudden and dramatic. Nevertheless, I believe it is indisputable that there has been a major and fundamentally healthy shift in attitude toward acknowledging the technical difficulties of effective safeguards. While this change has focused on the difficulties of safeguarding large bulk-handling facilities, it is by no means confined to this particularly intractable case.

This change in attitudes has been accompanied by a greatly intensified level of interest and inquiry, not just by outside critics but by the safeguards community itself, into how well safeguards are doing, and what needs to be done to improve them. In my judgment, this self-examination and greatly expanded R&D are evidence not of the failure of safeguards but of their underlying health and vitality. They are laying the foundation for what I am confident will be a stronger, more reliable, and more widely accepted safeguard system than what we have had at any time in the past.

Let me turn now to some concrete topics that either already are, or perhaps should be, areas of active interest in this new environment of inquiry and improvement.

Safeguard goals

A lively debate has arisen recently around the issue of what safeguards are, or should be, designed to accomplish.

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This involves such issues as:

- whether the adoption or enunciation of quantitative detection goals beyond current—and perhaps ultimate—capabilities distorts or helps guide the improvement of the safeguards system.
- whether there is a practical difference between systems in which the emphasis is on detection of diversion, and systems in which the emphasis is on verification of compliance.

In his recent excellent paper before the Annual Meeting of the Institute of Nuclear Materials Management, Hans Grümm of the International Atomic Energy Agency (IAEA) explained that the enunciation of tight quantitative goals on safeguards need not lead to unrealistic systems as long as the goals are recognized as such and interpreted reasonably. He also observed that there are trade-offs among the different safeguards objectives in any resource-limited system. For example: to achieve a higher detection probability, a higher false alarm probability may have to be accepted; if the time available for detection is reduced, the minimum diversion that is detectable may be larger.

There can be no disagreement that safeguards should strive to achieve the maximum performance values for each of its quantitative measures. There is something approaching consensus that, ideally, it would be desirable to be able to detect, with a high degree of assurance, the diversion of a quantity corresponding to an explosive device before that device could actually be constructed from the diverted material. The concept is not a new one. Although it is generally forgotten, the inspection frequency formula that was the central feature of the Agency's first safeguard system was based on limiting the uncertainty in a material balance for a facility of a given size to an amount corresponding to a nuclear explosive quantity. Thus, as the facility size was increased and the material balance uncertainty increased, more frequent inspections would be required. Implicit in this approach, but hardly corresponding to the real world, was the assumption that the material balance would be closed on the occasion of each inspection.

Notwithstanding this near consensus on what might be called the ideal situation, it is clear that in many practical situations, the desired results cannot be realized. Thus, trade-offs are made, whether deliberately or by default. My own bias is that the area where less than ideal performance can be accepted with the least sacrifice of overall effectiveness is that of detection probability. It takes only a glance to suspect that the conventional criterion of 95 percent detection probability was not analytically arrived at, but resulted largely by adoption of a common statistical yardstick.

In a resource-limited system, as any real-world system must be, the measures that are optimized for detection of diversion do not necessarily coincide with those that are optimized for deterrence. It seems probable that a nation contemplating diversion will not behave very much differently if it judges the probability of detection at 50 percent, than if it judges it to be 95 percent. What is likely to be most important in deterring diversion is the perception that diversion by any given pathway will be subject to a significant risk of detection. If this is so, and if deterrence is the priority objective, systems should be designed to introduce some finite risk of detection into every pathway that can be identified. Such a system, however, might have an unacceptably low overall probability of detection, requiring a shift in emphasis toward detection probability.

Unfortunately, the amount of data and experience on which to base any attempted trade-off analysis is limited. That this is so, however, does not mean that there is no basis for the exercise of informed judgment to arrive at a common sense result. As already noted, the trade-offs will be made in one way or another. It seems obvious that this should take place by the exercise of conscious choice rather than by default.

> *"The central controversy in safeguards today . . . is between the advocates of materials accountability and the advocates of containment and surveillance."*

Accountability vs. containment and surveillance

Intense development activity customarily generates spirited debates between proponents of differing approaches, and the current high level of safeguards development is no exception to this general rule. Such controversies are usually healthy and contribute importantly to successful achievement of the development objective.

The central controversy in safeguards today, particularly in relation to the safeguarding of large bulk-handling facilities, is between the advocates of materials accountability and the advocates of containment and surveillance. Given the ever-present problem of limited resources, there is a valid, indeed an unavoidable, need to properly relate these two safeguards approaches and even to make trade-offs between them. Nevertheless, the gap that seems to separate at least the more extreme positions being advocated today is surprisingly large, given past experience and current knowledge.

It is a truism, observed at least as long ago as the deliberations of the Agency Safeguards Committee of 1970, that if either material accountability or containment and surveillance performed perfectly and infallibly, then that approach would be a sufficient safeguards measure and the other would not be needed. It is simply because all experience, knowledge, and logic tell us that neither is infallible, that both are needed.

Consider materials accountability. The earliest safeguards studies led to the conclusion that materials accounting measures, except in the fortunate case where item accounting was possible, were subject to an unavoidable limit in the accuracy of materials balances, which could be expressed as a percentage of the inventory and flows to be measured. This uncertainty, when applied to facilities of large inventory or throughput, could mask diversions of sizable proportions.

Today, despite giant strides in measurement, analytical, and statistical techniques, this qualitative conclusion remains unchanged, and there is no basis for believing that future developments will permit a different conclusion. Thus, it must be accepted that materials accountability alone is likely to lead in a not inconsiderable number of cases to uncomfortably high levels of materials unaccounted for (MUF).

Consider containment and surveillance. Until recently, little effort and essentially no progress had been made in quantifying the effectiveness of containment and surveillance measures. Recent work under the auspices of the IAEA Expert Group on Reprocessing Plant Safeguards indicates that major progress is now being made in this field. Despite this welcome and important development, containment and surveillance are susceptible to a logical deficiency not present, at least in the same way, in materials accountability. This deficiency is the possibility that one or more diversion pathways have remained unidentified, and thus escape both surveillance and any possibility of placing a quantitative limit on the level of diversion that could go undetected. Designing facilities to reduce the number of penetrations that could provide diversion pathways would reduce both the cost and difficulty of containment and surveillance, as well as the risk of unidentified pathways. Even so, the logical difficulty would remain, and there is nothing in human experience to suggest that that deficiency would remain of purely academic concern.

Thus, it is the imperfection of both materials accountability and containment and surveillance that long ago led to the conclusion that both approaches were important and could complement each other. It does not follow from this that one measure can entirely overcome the deficiencies of the other, leading to a perfect system. What does result from their joint use, however, is an overall improvement in the final ability to conclude that diversion has, or has not, taken place.

To gain an understanding of how materials accountability and containment and surveillance interact, it is useful to consider the real-world cases of what, for want of a better term, I have called "accountability incidents." The results are interesting and not entirely in accord with conventional wisdom. In the classical scenario, some breach of containment or surveillance will trigger a careful material balance, which will resolve the suspicions one way or the other. In the case of both the Apollo and the Irwin, Tenn., incidents, unusually large MUFs triggered intensive material balance campaigns. After these campaigns failed to return MUF to conventional levels, official judgments, which were largely but not universally accepted, were reached—primarily on the basis of the presumed adequacy of materials controls—that no diversion had occurred.

Skeptics will argue that these incidents were purely domestic in nature, that the Agency's containment and surveillance is not analogous to domestic materials controls, and that the experience is therefore inapplicable to cases where the Agency's verified materials balances disclose unusually high MUFs. Fortunately, the issue has not yet been put to the test, but the domestic experience strongly suggests that when it occurs, materials accountability data alone will be unable to dispose of the uncertainty, and, in the absence of a strong Agency containment and surveillance effort, a generally accepted judgment will be difficult to reach.

Recently, there has developed a tendency to suggest that containment and surveillance has two distinct functions: to help establish the integrity of materials balance data and to attempt to detect attempted diversion directly. It has been further suggested by some that only the first function of containment and surveillance is realistic, leading to the conclusion that containment and surveillance designed directly to detect or deter diversion is not worth the effort.

The validation of materials balance data is indeed an important function of containment and surveillance, and there are undoubtedly specific instances of surveillance that relate only to this function. More generally, however, the ability of containment and surveillance to validate material accountability data derives precisely from the ability to reasonably establish that no unauthorized transfers, bypassing measurement points, have occurred. Thus, careful examination of this contention suggests that the distinction is largely an artificial one and that containment and surveillance can and must be used to detect and deter unauthorized movements if it is to perform either of its functions.

As the debate over the respective merits of materials accountability and containment and surveillance continues, there appears to be an emerging consensus in favor of the middle ground that both are important, and that practical safeguards systems must contain a judicious mix of the two. Clearly, the detailed nature of this mix and the resources to be allocated to each is a question of enormous complexity that will be answered only after considerably more R&D and systems analysis effort, and even then only on a facility-specific basis.

Independent verification

I hope that I will be excused if I revert now to an issue that I have long regarded as central to meaningful international safeguards: independent verification. This means simply that while the Agency may, as a practical expedient, employ information and data furnished by the inspected party, this information must, in the final analysis, be subject to confirmation on the basis of facts not supplied by or derived from the inspected party. Since there can be no genuine verification except independently, the term independent verification was a more or less deliberate redundancy chosen to give emphasis to its meaning and importance.

It is a perhaps interesting footnote to safeguards history that independent verification was the principal issue in the very first safeguards inspections, specifically, those conducted bilaterally by the United States prior to the development and implementation of the Agency system. The first inspections were of U.S.-supplied research reactors, and while the procedure was a simple one of item accounting of the fuel elements in the core and the cooling pond, the question immediately arose as to how, in an international context, the inspectors could assure themselves that items counted were in fact the fuel elements originally supplied, and not dummies or altered ones. The approach taken, which was not an entirely unassailable one, was that the validity of the fuel elements in the core was ascertained by observing reactor operating performance, which would have been significantly altered by the removal of one or more fuel elements. The integrity of the elements in the cooling pond was determined by observing their Cherenkov glow.

Today, more than 20 years later, not only is the issue of independent verification still of fundamental importance, but the original question of verifying the integrity of fuel elements is still the subject of extensive investigations.

An area of the independent verification issue that must be given increasing attention is that of establishing the validity of materials accounting data. Unless the integrity of each item of these data can be established, the resulting materials balances cannot be viewed as independently verified. To cite only one example, a determination of the plutonium inventory in the input accountability vessel of a reprocessing plant based upon liquid-level measurements and chemical analyses cannot be considered as independently verified unless the Agency can establish that the liquid-level measurement is, in fact, an unaltered reading of the accountability vessel measurement device, and unless the Agency receives a valid and unaltered aliquot of a representative sample of the tank contents. The possibility that a manometer reading can be falsified or altered, even if the Agency receives or examines the instrument printout, or that the sample has been altered before its arrival in the sampling gallery, is no more and no less credible than that a highly radioactive fuel element has been substituted for or altered.

The means by which the Agency can verify such measurements by and large fall in the realm of containment and surveillance, although there may in some instances be independent analyses that can serve this purpose. The implication of this point is of fundamental importance to the development of a safeguards system genuinely based on independent verification: it is that materials accountability that relies upon data and samples taken by the facility operator cannot be regarded as independently verified unless other measures, principally in the form of containment and surveillance, have been used to establish the integrity of the accountability data. This requirement further blurs the distinction between materials accountability, on the one hand, and containment and surveillance, on the other, and reinforces the conclusion that both are essential.

Establishing the integrity of surveillance data is equally important. In many instances, surveillance instruments are installed, maintained, and operated by the Agency itself, but this does not provide an automatic and full assurance of integrity given the operator's overall control of the facility. Reliable tamper indicating features are required on surveillance instruments. Redundancy, in addition to overcoming the consequences of instrument failure, can be useful in establishing integrity. The ability of the Agency to introduce its own standards into instruments, without the operator's knowledge, if possible, is also of great importance.

Current proposals for the use of improved accountability methods, generally referred to as near-real-time accountability, have tended, fortunately, to focus new attention on the question of independent verification. This results in part from the perception that this accounting approach involves greatly expanded use of on-line measurement instruments that, being under the operators' control, could be arranged to give false measurements. The example cited above of the possible falsification of measurements that are as crucial to conventional materials accounting as to the advanced techniques was deliberately chosen to illustrate the point that the need for and the difficulty of independent verification is just as great in both accounting approaches. To the extent that there is a difference, it is one of degree, arising out of the larger number of instruments and measurements implied by the application of near-real-time accountability.

Human surveillance

The emphasis on the development and use of safeguards instruments arising out several provisions of the NPT and INFCIRC 153 ("The Structure and Content of Agreements Between the Agency and States Required in Connection with the NPT"), as well as general considerations of safeguards costs and resources, carries with it some risk that the role of human inspection, particularly as a means of surveillance, may be downgraded. Despite the essentiality of instruments if excessive manpower requirements are to be avoided, humans also have an indispensable role in the continuous safeguarding of large bulk-handling facilities. While this role includes the monitoring and interpretation of instrument readings, it extends to maintaining a reasonable degree of direct surveillance for purposes for which instruments cannot serve in the foreseeable future. To make their maximum contribution in this role, inspectors must possess a level of process knowledge and operational insights comparable to those of the plant personnel themselves. Because of the turnover of Agency safeguards personnel, this will be a particularly difficult requirement to meet.

> "The expectation was that the (IAEA) document would be applied with considerable flexibility . . . exactly the opposite seems to be taking place."

INFCIRC 153

A somewhat troubling recent development has been the tendency to place strict and limiting interpretations on INFCIRC 153. As a participant in the Agency's 1970 Safeguards Committee, which produced INFCIRC 153, I have some sense of satisfaction that the Committee reached a reasonable result on the basis of then-current knowledge and that the document has served its purpose well. Nevertheless, it was clear to the participants even then that safeguards were bound to experience a rapid evolution. Thus, the expectation was that the document would be applied with considerable flexibility, as several provisions of the document itself make clear.

As institutional memory of the negotiating history is lost, exactly the opposite seems to be taking place. One example of this process is the restrictive interpretations often placed on the document's Section 29, which provides "for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures." Contrary to some recent suggestions, this provision was not adopted to limit the use of containment and surveillance below some past or proposed future level. Its negotiating history is precisely the opposite: it was intended to establish a clear mandate for containment and surveillance that was absent from INFCIRC 66 ("The Agency's Safeguards System").

Clearly, some meaning must be attached to the priority given materials accountability. The formulation of Section 29 obviously rules out, as one example, the complete abandonment of materials accountability. On the other hand, the language of Section 29 itself, coupled with other provisions of INFCIRC 153, does not provide and was not intended to provide some formula as to relative allocation of resources between the two approaches. A reasonable construction of Section 29, particularly in light of its proximity to Section 30, is that the system must provide for that degree of materials accountability that enables fulfillment of the requirement of Section 30 for a periodic materials balance statement. It is equally relevant that Section 28 calls for "timely" or "early" detection, and it was entirely clear, even in 1970, that early detection could not be assured by a system that lacked a substantial element of containment and surveillance.

Safeguards costs and financing

The development of safeguards to date has amply confirmed the long-standing premise that safeguards costs would represent a small and easily tolerable fraction of the cost of building and operating nuclear facilities—a cost, moreover, that contributes to safe and effective operation as well as to safeguards themselves. If anything, current safeguards costs are proportionately lower than originally anticipated in view of the steep rise in the costs of nuclear construction and operation. Despite this, safeguards financing has become an increasingly difficult and controversial matter, and the Agency's current safeguards activities, it would appear, are, for the most part, resource-limited.

In light of this situation, renewed consideration of the question of how safeguards should be financed appears to be called for. Even though the current Agency financing formula largely insulates developing countries from safeguards cost increases, and places the costs overwhelmingly on the industrialized countries that are the principal users of nuclear power, it may now be desirable to adopt an approach that more explicitly assigns safeguards costs to those countries that directly benefit from nuclear power.

Subjective considerations

While objective technical measures must play the central role in IAEA safeguards, it is inevitable and proper that the Agency, including the Board, will take a variety of other more subjective considerations into account when making judgments on the possibility of diversion. Some of this information will come from the application of safeguards themselves, in particular, the State's cooperation in the application of safeguards. Given the State's vested interest in the avoidance of suspicion as to the purpose of its nuclear power programs, approaching safeguards in a legalistic and unduly restrictive way cannot be in the State's interest.

Safeguards development and implementation to date have generally confirmed the premise that safeguards would not be intrusive. Effective implementation of the technically difficult task of safeguarding large bulk-handling facilities will hardly be furthered by unnecessarily strict interpretations on the part of the States concerned. Similarly, such behavior can hardly avoid arousing unnecessary concerns. As a consequence, a genuinely cooperative approach to safeguards implementation, as called for by INFCIRC 153, may be the single most cost-effective way of improving safeguards.

Conclusion

Beyond the current concerns over the adequacy of safeguards, an unprecedented effort is under way, in which a number of countries are cooperating, to develop improved safeguards technology as well as an improved understanding of safeguards concepts. The progress already made in this effort provides substantial grounds for the conclusion that, with adequate resources and State cooperation, safeguards can measure up to the challenge of providing a reliable assurance of compliance with nonproliferation undertakings.

Le 8 Août 1980.
AP/FR

NON PROLIFERATION AND SAFEGUARDS

A VIEW FROM FRANCE

REMARKS by André PETIT
technical adviser
to the Director for International Relations - Commissariat à l'Energie Atomique.

As indicated in our Program, I am not supposed to express here "the french view" on this problem, but only "views from France" which of course are only my personal views, and can not be considered beeing those of the French Government, nor of the C.E.A.

But before doing so, it seems appropriate to recall the basic elements of the French Non-Proliferation Policy as they stand at present :

I°) Although not à Signatory of the N.P.T., the French Government has declared in the United Nations General Assembly that it would behave exactly as if it had signed it.

2°) This declaration has been confirmed by the french participation in the establishment of the so-called "London Guidelines" (published by the I.A.E.A. under the reference INFCIRC 254) which include, for the nuclear weapons States, the same export rules as the N.P.T. itself.

3°) The French Government is also bound by those provisions of the London Guidelines which go beyond the N.P.T. and which especially relate to restraint to be exercised in the export of weapons usable material (i.e. separated plutonium and uranium enriched beyond 20 %) and sensitive equipments and technologies (I.e. reprocessing, heavy water production, and uranium enrichment).

4°) Within this framework, the "Conseil de Politique Nucléaire Extérieure", under the Chairman ship of the President itself, establishes and updates as appropriate the french non-proliferation policy. This has been done by a number of decisions among which I want to underline the adoption on II October I976 of some basic principles and the decision made on I6 December I976 not to export reprocessing plants under national control (which are attached).

If one wants to summarize this policy very roughly, one could say that it is more restrictive than the London Guidelines with respect to the export of reprocessing plants, but that it did not adopt the optional provision of these guidelines concerning the "prior consent" on reprocessing and high enrichment which other countries adopted, and that it underlines the french will to assure nuclear fuel and nuclear fuel services supplies to countries to which it exports nuclear power plants.

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x x

Let me come now to some personal comments on the situation and the possible future developments. By doing so, I will try to make an exception to a general rule which most of you have probably noticed : it is that, when speaking about non-proliferation, most people with a technical background develop mainly political arguments, and most people with legal or political background develop mainly technical arguments. But my reason for doing so is not so much my own background, but the fact that I am really convinced that non-proliferation is essentially a political problem and that, although technical aspects must also be taken into consideration, their role can only be ancillary.

This has been clearly demonstrated by the International Nuclear Fuel Cycle Evaluation, which contrary to what some politicians had expected, came to the clear conclusion that there is no nuclear fuel cycle which could be considered completely exempt from proliferation risks. Any nuclear knowledge, and any nuclear material can be used, directly or indirectly to produce nuclear explosives if a Government decides to do so.

The only I00 % effective non-proliferation policy would theoretically be the one which was adopted by the U S after the war : secrecy and no exports of nuclear material or technologies. But even this one was not I00 % effective as it didn't prevent the Soviets the British and the French to manufacture their own nuclear weapons.

On the contrary, it can be claimed that the American "Atoms for Peace" program, by encouraging nuclear trade under appropriate safeguards, has probably been more effective in preventing proliferation than the preceeding "secrecy" policy.

This is due to the fact that the most essential component of a nuclear military program is not the nuclear material nor the nuclear technology, but the political will, supported by a minimum of scientific and industrial capacity. If the political will is there, any country will, sooner or later, succeed in producing and creating the necessary nuclear material and technologies. If it is not there, it is not the mere presence in a country of nuclear material in a power production fuel cycle under safeguards which creates a proliferation risk.

This means that the main objective of any non-proliferation policy must be to act in such a way as to prevent the existence of such wills.

This is to be done first by trying to make this world safe and peaceful for all countries, which is a matter to be dealt with by politicians and diplomats - not by us.

The second way of contributing to this objective, is to act in such a way, as to convince non-nuclear weapons States that the best interest of their energy policy and general economics, will be better served through non-proliferation rather than through proliferation.

This supposes that the free development of their nuclear energy policy be not hampered by undue restrictions, and that they be able to rely confidently on a sound and diversified international nuclear market for the implementation of such policy. If not, those in such countries which are keen of independent energy policy and industrial development would join those who may wish to acquire nuclear weapons, and give them a good excuse to develop national autarkic nuclear programs which may be unsafeguarded, rather than developing cooperation under safeguards.

This is the reason why INFCE so much insisted on security of supply as an essential tool of non-proliferation policy.

But such a security of supply can not, inturn, be establishd without firm non-proliferation commitments supported by a worldwide and well accepted international safeguards system.

In this respect, it is important to underline that the need for safeguards comes not only - if at all - from a lack of confidence by the exporter, in the non-proliferation commitments made by the importing country. The exporting country must take into consideration as well, if not even more in some cases, the distrust some third countries may have in respect of the non-proliferation commitments of the importing country.

This is the reason why an universally accepted set of international multilateral safeguards, such as the one of the I.A.E.A. is essential for a worldwide non-proliferation policy. Bilateral safeguards could be enough to give confidence to a aupplier in the commitments of the importer. But only I.A.E.A. safeguards can give confidence, to the international community as a whole, that international nuclear trade, whoever the participants may be, only serves peaceful purposes.

By doing so I.A.E.A. safeguards allow nuclear trade to develop multilaterrally, rather than being constrained into a set of bilateral agreements superimposed on eachother.

I do not think it is necessary nowadays to demonstrate the superiority of multilateral trade over bilateral trade, be it in economic terms or in terms of security of supply. In economic terms, the General Agreement on Trade and Tariffs (G.A.T.T.) has, for a long time, demonstrated the fact. In terms of security of supply, the example of the oil market shows how keen countries are to diversify their supplies, and how reluctant they are towards any attemps by a group of producers to dictate unilaterally their will

It would be irresponsible, for those who are in charge of the development of nuclear energy and of non-proliferation, to suppose that any country would be ready to develop its nuclear power program only under bilateral agreements with supplier countries. If these countries can not rely on a sound multilateral nuclear market, they will necessarily be led, in the medium or long term, to develop nationally all the fuel cycle stages they need, in order to avoid being dependant on bilateral agreements.

Of course, when saying that, I do not forget the fact that many countries, for the time being, do not accept to authorize nuclear exports if not under bilateral agreements.

The climate of mistrust in some areas, and the special political sensitivity surrounding some materials and techniques, are still such that these restrictions are likely to remain for some time, at least for the most sensitive nuclear materials or technologies.

But it is not suddenly, one day, that the world will pass from the present situation to an ideal one where international trade of any nuclear material or technology could develop multilaterally and freely under a set of universally agreed conditions.

If and when such a situation will occur remains an open question. But pending this hopefull outcome, the main objective of our efforts should be to always enhance the international confidence in I.A.E.A. Safeguards in order to constantly increase the geographical and technical area within which multilateral trade can take place under the sole condition of the application of these safeguards.

For the time being, this is the case for roughly half of the natural uranium, low enrichment, and power reactors exporting countries.

As a first step towards a worldwide more satisfactory situation, we should try to have all countries accepting such free multilateral trade under I.A.E.A. safeguards for this basic part of the fuel cycle. This could possibly be facilitated if the I.A.E.A. was able to implement the provisions of its Statute concerning the storage, with the Agency, of any separated plutonium in excess of actual needs, thus removing the need, for some countries, to request prior consents on reprocessing.

The free trade and reexport of plutonium or highly enriched uranium would certainly raise greater problems and is only to be considered in a longer range.

But even the first of these two steps is unlikely to be achieved completely nor by all countries at once, which means that some nuclear trade under bilateral conditions is likely to remain in the coming years.

But they are ways to achieve anyhow the greatest possible level of multilaterality in such a context. In order to increase proportionnaly the security of supply and thus reduce the proliferation risks.

The first would be, for all States which request additional conditions, to ask the I.A.E.A. to safeguard such provisions, rather than establishing bilateral tracking of their material in order to check the correct implementation of these conditions. This would allow at least, a certain degree of multilaterality in the trade, among countries imposing and accepting the same set of conditions.

The second would be, for such States, to accept automatic retransfer of such materials or equipments to all countries having accepted the same conditions.

I know that these suggestions which, I underline, are quite personal, will raise objections from those who believe that, non proliferation conditions additional to the N.P.T. being abnormal, the I.A.E.A. should not cooperate to their safeguarding.

But I personally believe that the I.A.E.A. as such has not to be involved in arguments concerning the appropriateness or not of non-proliferation conditions. Already now it safeguards some types of non-proliferation conditions for non-N.P.T. signatories, and different types for N.P.T. signatories. It is up to each State to decide whether or not it wishes to impose or accept additional conditions. But once such conditions are accepted, I see only inconvenients and no profits in having them safeguarded bilaterally and not through the Agency.

This approach may appear too timorous as well to those who think that any restrictions additional to the N.P.T. should be immediately suppressed, and to those who think that such additional restrictions should immediately be made universal.

But we are in the field of politics, and there is a clear political evidence that neither situation will be reached, if ever, before long years. In the meantime anything which can enhance multilateralism in nuclear trade (and thus security of supply and non-proliferation), should be wellcome, even if it does so only partially.

CONCLUSION

Divergences of opinions about the best non-proliferation policies, very often reflect a difference in the time-range people are considering.

In the short-range, it is clear that, if you do not deliver uranium or reactors or any other equipment to a country which has no experience of producing it, you will necessarily delay with some years the time when such country will have the corresponding nuclear capacity, and thus, the time when it could divert it to nuclear weapons production by breaching its non-proliferation commitments.

But in the long range it is also clear that the incentive to build autarkic nuclear capacities, unsafeguarded or on which safeguards commitments may be politically easier to resign, will be that much greater if the non-nuclear-weapons-States have the feeling that they can not rely on the international market for developing their nuclear energy programs, without being limited in the technical and economic choices for this development, and subject to political pressures of all kinds.

I am very often surprised to see people who claim being the strongest supporters of non-proliferation in the interest of the peace of the world, adopt the first approach rather than the second. If the peace of the world is at stake, it is not only important for the three or four coming years, but as well in the future decades. Indeed, any policy which would reduce the risk of proliferation in the short range, at the cost of increasing it in the long range, is not a responsible non-proliferation policy.

No technical fixes existing to prevent proliferation, it can only be prevented by political commitments complemented by appropriate international safeguards. These can not be imposed, and need the consensus ot the international Community. Such consensus is unlikely to develop and remain if non-nuclear-weapons States have the feeling that their economic development or energetical independance are thus hampered, and if exporting countries are not confident in the efficiency of I.A.E.A. safeguards.

This is the reason why the main efforts of the world-wide non-proliferation policy should be concentrated on the constant improvement of I.A.E.A. safeguards. Improvement in their scope in order to facilitate as much as possible multilateral trade and thus security of supply and non-proliferation objectives. Improvement in their efficiency, which relates as well to their deterrence effect on a would-be proliferator State, and to the possibility of doing so within reasonable human and financial means, and without unduly hampering the normal industrial management of the nuclear industry.

COMMUNIQUE OF THE CONSEIL DE POLITIQUE NUCLEAIRE EXTERIEURE

(Council for External Nuclear Policy)

11 October 1976

1. For a number of countries, nuclear energy represents a competitive energy source which is necessary for their development. France is therefore still prepared to contribute to the development of its peaceful applications.

2. France intends to keep control of its nuclear export policy in accordance with its international obligations in this field.

3. France will not favour the proliferation of nuclear weapons. In its nuclear export policy, it will strengthen the appropriate provisions and safeguards relating to equipment, materials and technology.

4. France will assure the provision of nuclear fuel for the nuclear power plants supplied by it and will meet legitimate needs for access to the technology. It will also provide the fuel cycle services requested of it. It is ready to study with interested parties the question of bilateral or multilateral agreements capable of guaranteeing this.

5. The French Government considers it essential that all suppliers of nuclear equipment, materials and technology avoid favouring - through commercial competition - the proliferation of nuclear weapons.

6. It is ready to discuss these problems both with supplier countries and with non-supplier countries engaged in substantial nuclear power programmes.

COMMUNIQUE OF THE CONSEIL DE POLITIQUE NUCLEAIRE EXTERIEURE

(Council for External Nuclear Policy)

16 December 1976

True to its peaceful and humanitarian traditions, France intends not to contribute to the terrible threat constituted by the proliferation of nuclear weapons.

Applying the principles laid down on 11 October by the Council for External Nuclear Policy, the French Government has decided no longer to authorize - until further notice - the conclusion of bilateral contracts concerning the sale to third countries of industrial facilities for irradiated fuel processing.

It recalls, in conformity with its declaration of 11 October, that, as nuclear energy represents for a number of countries a competitive energy source which is necessary for their development, France is still prepared to contribute to the development of its peaceful applications in accordance with the principles which it has stated.

INFCE SUMMARY VOLUME

(Excerpt)

V-B. Safeguards

A central feature of the current non-proliferation regime is a network of bilateral and multilateral agreements by which states undertake to accept international safeguards on some or all of their nuclear activities. Safeguards are generally implemented by the IAEA under agreement with the states involved. Although the content of the undertakings varies somewhat, particularly as to what would trigger international safeguards, states subject to safeguards can generally be divided into two broad groups: *First*, states that have accepted international safeguards on all of their nuclear activities, whether by adherence to treaties like the Non-Proliferation Treaty or the Treaty of Tlatelolco, which so require, or otherwise. Safeguards applicable under the NPT are elaborated in the IAEA document INFCIRC/153. In that case, the objective of safeguards is "the timely detection of diversion of significant quantities of nuclear materials from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection". *Second*, states that have accepted safeguards only with respect to specific imports of nuclear materials, equipment and technology, leaving open the possibility that some activities in relation to nuclear energy would not be subject to international safeguards. The applicable safeguards in these cases are essentially defined in the IAEA document INFCIRC/66/Rev.2. The purpose of safeguards is then "to ensure that special fissionable and other materials, services, equipment, facilities and information ... are not used in such a way as to further any military purpose". There are cases where a country which has adopted safeguards according to INFCIRC/66/Rev.2 has put all its existing nuclear activity under safeguards. The existing safeguards regime relies primarily on materials accountability within material balance areas, with containment and surveillance as important complementary measures. These safeguards measures are verified by inspections conducted by the IAEA under the terms of the safeguards agreements already referred to.

An examination of the adequacy of the safeguards regime was a part of the terms of reference of working groups dealing with a specific phase of the fuel cycle. The groups did not identify significant problems with the capability of methods and techniques as applied to existing operating plants. Further development and improvement of existing methods and techniques were foreseen as necessary to meet safeguards objectives at reasonable costs, in connection with technologies for uranium enrichment, industrial-scale reprocessing of irradiated fuel, and mixed oxide fuel fabrication for LWRs or breeder reactors, all of which involve the possibility of access to special nuclear material in a form usable for the construction of nuclear weapons. Such development should in general include taking account of safeguards needs in the design of facilities, enhanced containment and surveillance, and improved methods of materials accountancy. Effective international safeguards are seen as an essential feature of the nuclear power industry and a substantial additional effort involved in safeguards should be regarded as of importance.

Working Group 2 stressed that the measurement techniques for UF_6 at the material balance boundaries of gaseous diffusion, nozzle and centrifuge enrichment plants are highly accurate, thereby enhancing the ability of materials accountancy to detect the possible diversion of a significant quantity of nuclear material. Accurate materials accountancy, together with verification of design information and effective containment and surveillance measures, should allow the timely detection of the misuse of a safeguarded plant, as well as of the diversion of nuclear material. If non-access areas are established to minimize the proliferation risk due to access to and propagation of sensitive technology, then these areas should be defined in such a way as to permit effective and efficient safeguards. Although this limited access may be considered as a complication, this might be compensated for, for example, by the application of appropriate containment and surveillance measures. For the time being, the main effort to be considered in R&D would therefore focus on improvements in safeguards cost effectiveness and containment and surveillance measures. Automation could be used in the future for monitoring of personnel and material movements in order to reduce as far as possible the inspection efforts and the resulting costs, without decreasing the effectiveness of safeguards measures.

Working Group 4 stated that experience with the implementation of international safeguards in reprocessing plants and subsequent finishing processes to mixed oxide fuel is limited, but a useful case history is being built up. To date, the safeguards system for such plants has been based on materials accountancy, supplemented by limited containment and surveillance measures. This combination is generally capable of providing effective international safeguards for existing operating plants. The experience gained to date can provide a useful basis for the evolution of new and improved safeguards techniques for which a number of concepts and measures are now at various stages of development. All of these would include current materials accountancy procedures augmented by various improved techniques of containment and surveillance; some would also include in-process measurements. Of particular importance in this connection would be to design sensitive installations with a view to making safeguards easier to apply. Again, Working Group 4 concluded that for future reprocessing and mixed oxide fuel fabrication plants it will be essential to take full account of criteria for effective international safeguards from the inception of plant design, together with the resultant cost. The design stages should include an evaluation of the overall safeguards strategy proposed. This evaluation would be based on safeguards authorities' and operators' experience and on field tests, and should take into consideration the cost and resource effectiveness of the total system. Working Group 4 concluded that substantial improvements resulting from the studies and developments now underway should be applied to future industrial-scale reprocessing and mixed oxide fuel fabrication plants in order to meet safeguards objectives at an acceptable cost. It also concluded that the safeguarding of plutonium storage facilities and plutonium transport can be readily carried out on the basis of item accountancy and extensive use of containment and surveillance techniques.

Working Group 5 stated that safeguards measures for the FBR cycle are being further developed in the light of its specific characteristics and there are prospects for future improvements in cost effectiveness, along the lines of both accountancy and containment/surveillance. In designing new plants it is necessary to take into account measures to facilitate the effective implementation of safeguards. These techniques, when combined, will enhance each other's effectiveness and should enable effective safeguarding to be applied to future commercial FBRs, reprocessing and fuel fabrication plants at an acceptable cost.

Safeguards for spent fuel storage and transport are implemented according to national or multinational requirements and bilateral and IAEA agreements. Current safeguards measures for different types of spent fuel storage (AR and AFR) are in general similar and well established. They are independent of location and consist of materials accountancy complemented by containment and surveillance. Materials accountancy is based on item identification and item counting, supplemented in some cases by non-destructive measurement. The containment and surveillance measures include the use of specially designed seals and various forms of surveillance devices.

The impact on safeguards requirements of new storage techniques is not yet known, but present safeguards arrangements appear to be adequate for future large storage facilities based on present technology. It is important that when future facilities are at the design stage the requirements for improved containment, surveillance and materials accountancy techniques should be taken into account.

Similarly, Working Group 7 concluded that, because of their relative unattractiveness for the production of nuclear weapons, most categories of nuclear waste are likely to meet the IAEA criteria for termination of safeguards prior to their disposal. An exception is spent fuel from once-through fuel cycles, which, though initially unattractive because of the radiation barrier, becomes more accessible with time. Safeguarding of spent fuel, which is contained in canisters and thus amenable to item accountability and inventory verification, would be relatively straightforward during transport and emplacement in the geologic repository. Following that, successive backfilling of emplacement holes, storage rooms and galleries would provide increasing containment. After closure of the facility, on the assumption that the repository is designed for irretrievability, even very cursory surveillance would ensure the timely detection of diversion operations since these would require massive mining equipment, a large work force and surface disposal of mined rock and earth. However, the surveillance effort will extend over an indefinite period. Facilities are currently also being contemplated for interim storage of canistered spent fuel over an indefinite period of time, pending a decision on whether the fuel will be reprocessed or disposed of. In that event, the encapsulation could well be preceded by pool storage of the fuel assemblies for a period much longer than the 10 years assumed in the Working Group 7 report. It will be clear that, as the radioactivity of the spent fuel decreases with time, the diversion risks, and thus the required safeguarding effort, of such extended storage would both increase.

Working Group 8 concluded that for the thorium cycle appropriate safeguards procedures and equipment are being developed, taking into account the specific radiation characteristics of these cycles. The procedures are still in a formative stage and can be expected to evolve with increasing experience.

Euratom: Non-Proliferation and Safeguards in the 1980's

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International Executive Conference on
on Non-Proliferation and Safeguards

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1. POLITICAL DEVELOPMENT

The first attempt to limit the proliferation of nuclear weapons internationally was made very shortly after the use of such weapons at the end of the second world war. In fact the Baruch Plan of 1946, put to the United Nations, was the first proposal for an international control, but it was not possible to get it accepted internationally. It was only about ten years later, when other states had also developed nuclear weapons, and the civil application of nuclear power - particularly through the "Atoms-for-peace" program of the U.S. - had made a promising start in many countries, that the first concrete steps towards international safeguards were possible. In 1956 the Statute of IAEA was agreed upon, and when this entered into force in 1957 it allowed an international authority to apply safeguards where so agreed by agreements between states.

At about the same time (1957), six Western European states signed the Euratom Treaty, by which the signatories accepted the application of safeguards by a supranational authority - the Euratom Commission - on their complete civil nuclear fuel cycles. The Euratom Safeguards system was thus the first international - or rather supranational - safeguards system covering a region with a number of industrially highly-developed countries.

The decision to include a safeguards system in the Euratom Treaty - which is itself not limited to safeguards but has the general scope to foster the development of peaceful nuclear energy in the Member States - was a political act based on the recognition that international collaboration and trade in the peaceful nuclear field is not really possible without having certain assurances that the partners do not use materials or technologies for non-peaceful purposes.

The attitude of the Member States of the European Atomic Energy Community (i.e. Euratom) has been consistent with this principle through all the following years.

In 1968 the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was opened for signature, and within a few years all the non-nuclear weapon Member States of Euratom had adhered to it. One - at that time future - Member State, the United Kingdom, was even one of the initiators of the NPT, and one of the Depositary Governments.

As the NPT foresees that all NNWS's party to it accept IAEA safeguards, an Agreement was concluded between IAEA, the Community and its NNW-Member States in 1973 for the application of NPT safeguards. This is now in full implementation, and the IAEA, in applying its safeguards, makes use of Euratom's Safeguards system. A similar agreement was signed in 1976 between the IAEA, the Community and the United Kingdom. It foresees IAEA inspections in certain facilities selected by the IAEA (whereas the whole civil fuel cycle is under Euratom Safeguards). This Agreement is now also in force.

A further Agreement, between the Community, the IAEA and France (which although not a signatory to the NPT, follows a non-proliferation policy as if it were a signatory) has been signed, and is in the process being discussed in Parliament prior to ratification.

A new level in the context of international non-proliferation policy was reached with the establishment of the so-called "London Guidelines" for export of nuclear technology and equipment (1975/76). These in fact are complementary to NPT provisions (which deal only with nuclear materials) even if the guidelines are not fixed in the form of an agreement, but as identical unilateral declarations by a number of states who are actual or potential exporters of nuclear technology and know-how. Three Member States of the Community - U.K., France and the Federal Republic of Germany - were amongst the founders of the "London Club", and the three others with significant nuclear industries - Italy, Belgium and the Netherlands - joined it later.

With these developments, political efforts concerning non-proliferation and safeguards have, of course, not come to an end, as international discussions on different subjects, such as the International Fuel Cycle Evaluation (I.N.F.C.E.) demonstrate. The Community and its Member States have always been very active and constructive in these initiatives and they will certainly continue to be so in the future.

In what follows, I will put the main emphasis on safeguards aspects, and will come back later to some more general problems.

2. STRUCTURE OF EURATOM

In order to have a better understanding of the nature of what is called "Euratom", it seems useful to briefly recapitulate the legal and contractual structure in the Community.

The Euratom Treaty is one of the three basic treaties of the European Community (the two others being the Coal and Steel Treaty and that of the Economic Community, the "Common Market"). All three Treaties are administered by a single, independent Commission; a Council of Ministers, comprising representatives of the Member States, makes decisions on the proposals made to it by the Commission; a Parliament, elected directly by the population of the Member States, requires to be consulted before decisions are taken, has well defined powers on the budget, and has the power to censure the Commission. The European Court of Justice decides on questions of Community law, and of the impact of Community law on national law.

There are now 9 Member States (of which two are nuclear weapon states), and next year, with the accession of Greece, there will be 10.

3. RELEVANT PROVISIONS OF THE EURATOM TREATY

Chapter VII of the Treaty deals with safeguards. In its first article (Art. 77) it is stipulated that, "in accordance with the provisions of this Chapter, the Commission shall satisfy itself that, in the territories of Member States,

(a) ores, source materials and special fissile materials are not diverted from their intended uses as declared by the users;

(b) the provisions relating to supply and any particular safeguarding obligations assumed by the Community under an agreement concluded with a third State or an international organisation are complied with."

This article is the fundamental basis for the safeguarding activity of the Commission, the other articles of this chapter specifying the means and the limits for it. The second part of the quoted article, relating to the observation of supply conditions shows that there is a particular aspect not normally covered by international safeguards (such as carried out by IAEA under NPT). This is to be seen in relation to Chapter VI of the Treaty, which deals with supply.

In Chapter VI it is provided that the supply of ores, source materials and special fissile materials shall be ensured by means of a common supply policy on the principle of equal access to sources of supply, and a special Agency is created for this purpose. This Agency has a right of option on the production of materials coming from inside the Community, and a right to conclude supply contracts for materials coming from outside the Community; the Commission may authorize export of special fissile materials produced in the Community, with the possibility of refusing such authorization if there are not sufficient guarantees that the general interests of the Community will be safeguarded or if the terms of export contracts are contrary to the objectives of the Treaty.

The chapters on safeguards and supply provide therefore a competence to the Community in the fields of interest to us here, even if such terms as "general interests of the Community" might require definition in specific cases.

4. SAFEGUARDS AGREEMENTS WITH IAEA

The prime basis for Euratom Safeguards is the Treaty. In addition, three Agreements with IAEA regulate the relationship between the regional Euratom Safeguards system and the worldwide IAEA system. These Agreements are based on the model agreement, INFCIRC/153, and each foresees, as specified in particular in their Protocols and their Subsidiary Arrangements, a very close coordination between Euratom and IAEA Safeguards activities. Euratom thus acts as the primary safeguards authority, collects and verifies the accounting reports and transmits these reports to Vienna, and carries out inspections, at which Agency inspectors may frequently be present. In installations dealing with significant amounts of high enriched uranium or plutonium, and in enrichment plants, groups of inspectors drawn from both organizations are in fact now working closely together as joint inspection teams.

In order to enable the Commission to fulfil the obligations towards IAEA, new safeguards regulations had to be edited for application within the Community. They set out, in a general way, the obligations the operators have towards Euratom, defining e.g. what installations are subject to safeguards, what declarations have to be made on design information, what records and reports shall be maintained and transmitted etc.

More specific obligations are imposed by means of "Particular Safeguards Provisions" prepared by the Commission for each individual installation, which enable - where necessary - the Commission to respond to the specific requirements of the "Facility Attachments", concluded between the Commission and the IAEA.

5. SAFEGUARDS IMPLEMENTATION

The amounts of nuclear material currently under Euratom Safeguards are, in round terms, the following:

Plutonium	35 tonnes
Highly Enriched Uranium	13 tonnes
Low Enriched Uranium	10,000 tonnes
Natural Uranium	28,000 tonnes
Depleted Uranium	14.000 tonnes
Thorium	1,300 tonnes
(Heavy Water	440 tonnes)

These stocks are distributed through the nine Member States in about 400 installations of all sorts of different categories, from research laboratories (about 80), storage facilities (about 80) and non-nuclear users to research (50) and power (55) reactors, fuel conversion (8), enrichment (4) and fabrication (21) plants and reprocessing plants (9).

All the current industrial-scale fuel cycles are represented, e.g. natural uranium gas/graphite, low enriched uranium advanced-gas, boiling- and pressurised-water, heavy water, materials-testing and fast reactors, together with the necessary associated plants for fuel production and reprocessing. More limited facilities exist for other less fully developed cycles e.g. the pebble-bed high temperature gas concept.

It may be worth mentioning that the enrichment plants cover both diffusion and ultra-centrifuge technologies, and that the reprocessing plants (omitting laboratory-scale experiments) deal with natural, low-enriched, high-enriched, and MOX fuels in metal, alloy or oxide forms.

The European Community is thus by far the most important coherent region in the world currently under a unified supranational safeguards system.

The Euratom Safeguards Directorate, composed of European civil servants from all Member States, disposes of nominally about 90 inspectors of whom nearly 60 regularly carry out inspections in the nuclear installations.
Portable, transportable and permanently-installed non-destructive measuring equipment is widely available and regularly in use; chemical analyses are mainly performed by the laboratories of the Community's Joint Research Centre. Containment and surveillance techniques are being increasingly applied, for example some 30 film camera units, each containing two cameras are available, and two twin-camera video units are in service. Utilisation of seals is running at about 5000 paper seals per year, about 5000 general purpose (copper-brass or ultra-sonic) seals per year and about 500 ultra-sonic rivet seals in SAP for MTR fuel elements per year.
The Accountancy Service treats and checks about 15,000 data entries each month.

To this has to be added the activity of the IAEA Safeguards Department simultaneously deployed in the same area. This shows that in the territories of the E. C. the effort spent on safeguards is very high.

It is not possible to describe here the details of the methods and techniques used. Most installations have a long experience with Euratom Safeguards and in the same way the inspectors know the plants and their specific problems well, so it is often possible to find practical solutions to problems as they arise, even if agreement on formal documents such as Facility Attachments has been sometimes difficult to obtain, especially since such plant-specific papers had not been required as long as Euratom was safeguarding alone - partially because of its far-reaching rights of access.

The coordination with IAEA is working - after the inevitable little problems of the running-in period - better and better. Mutual recognition and appreciation and clear delimitation of competences and duties, both in general and in specific cases, help to create an atmosphere for efficient collaboration. The general principle that duplication of inspection activities has to be avoided whenever possible is a guarantee to the operators against undue burden, and I think that in fact no significant disadvantages result for them from this dual safeguards system.

6. FUTURE DEVELOPMENTS

Safeguards procedures are not clear technical procedures which can be fixed once and for ever. They are there first of all to serve a political objective, and they therefore have to be modified in the light of changes in the objective, and further they have to be adapted to take account of technical developments. For example, as long as key technologies, such as enrichment and reprocessing, were only in the hands of some states regarded as "reliable" or even only of states already in possession of nuclear weapons, such plants were not of the greatest concern. But as more and more states acquire such technologies, the need to apply efficient safeguards at such points of the fuel cycle gets more and more important. And as the size of such plants increases - for various different reasons - safeguards have to become more and more complex and sophisticated, partly, but not entirely, because of limits imposed by the accuracy of routine measurements.

In the implementation of safeguards in the 1980's it will certainly be necessary to obtain faster and more precise assurance with less effort both from the safeguards authorities and from the plant operators, as it would otherwise be very difficult to cope with the predicted, and expected, development of the nuclear industry. Taking account of safeguards aspects during plant design, a wider use of containment and surveillance, and more electronic data treatment and transmission will all certainly help to make safeguards more efficient. But these alone might not be sufficient, and it will - at least in certain cases - be necessary to review the general approach, which is in principle still governed by the determination of "material unaccounted for" (MUF) at the time of complete inventory-taking and -verification.

On the more political side, the idea of creating international plutonium storages is certainly an attractive one, and the Community and its Member States are actively participating in the international discussions on this subject. The general idea is in fact not new. Both the Statute of IAEA and the Euratom Treaty contain provisions which allow the respective authorities to establish stores for the deposit of fissile materials. No practical implementation of these provisions has, however, been made up to now, and before this can be realized, many problems of a political and a technical nature will have to be solved. One of them is that Agency safeguards would probably have to change its nature, in the sense that a verification of the specific "use" of materials might be required. For Euratom this would not be a problem, as the use of the material has to be declared by the operators and is to be verified.

A specific task of Euratom Safeguards, which is not paralleled by the IAEA, is the control of the specific obligations accepted by the Community in supply contracts. The fact that this control is performed by the supranational Euratom Commission has permitted the supplier states to renounce their potential right to inspection by their own inspectors. The control of these conditions necessitates, however, some tracking of the material, which is not always easy when material is mixed - which is very often an operational necessity. Additional complexities arise when materials get double labels - e.g. material of Canadian origin enriched in the United States. When negotiating new or renegotiating existing agreements the Community will have to insist that these problems - which are in fact not really non-proliferation problems - are satisfactorily resolved.

The political and technical scene of non-proliferation and safeguards is at present moving quite rapidly. The second NPT Review Conference which has just been held in Geneva, has brought some new aspects into the discussion and will perhaps require certain adjustments of policies. But there should be no weakening in the general aims which are based on a worldwide consensus on principles, which all Members of the European Community support in full measure.

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PRESS RELEASE

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STATEMENT BY DR. SIGVARD EKLUND, DIRECTOR GENERAL OF THE INTERNATIONAL ATOMIC ENERGY AGENCY TO THE IAEA BOARD OF GOVERNORS

Vienna, 6 July 1981 -

The Board will recall that, at the start of the last session of the Board on 9 June, I made a statement concerning the Israeli air attack, on 7 June, on the Iraqi Nuclear Research Centre at Tuwaitha, near Baghdad. That statement was supplemented by a further statement I made on 12 June.

The text of the resolution adopted by the Board on 12 June and the relevant summary records of discussions on this matter in the Board were transmitted to the United Nations Security Council.

On 17 June, the Security Council decided to invite me to New York in the course of its consideration of this matter and I addressed the Security Council on 19 June. The texts of my statement and the resolution which was adopted unanimously by the Security Council on 19 June on this subject have already been circulated as document GC(XXV)INF/196 and are before the Board.

The resolution speaks for itself; in particular, I should like to draw attention to the operative paragraph 5 of this resolution calling upon Israel urgently to place its nuclear facilities under IAEA safeguards. The Secretary General of the United Nations has been requested to keep the Security Council regularly informed of the implementation of this resolution.

The Board will recall that in my statement on 9 June, I had mentioned that the last safeguards inspection at the Iraqi Nuclear Research Centre was undertaken in January of this year and all nuclear material was satisfactorily accounted for. Another safeguards inspection had been planned by the Agency for early June but it was postponed to the end of the month at the request of the Iraqi authorities because of the presence of their senior officials concerned at the Board. In view of the attack on 7 June, I requested that the date of the inspection should be advanced, and the Agency inspectors visited the Iraqi Nuclear Research Centre on 18 June.

They were not able to approach the damaged facility and to inspect the fuel for the Tamuz reactors, because of suspected unexploded bombs and the extent of the damage. The Iraqi authorities were agreeable to the facility being inspected on condition that the inspectors signed a waiver relieving the Iraqi Government from any responsibility in respect of their personal safety. The inspectors were not in a position to do this. However, the inspectors visited the IRT/2000 reactor which was not damaged and the storage containing natural and depleted uranium and yellow cake and observed no changes since the last inspection. The inspectors requested the Iraqi authorities to submit a special report and to keep the IAEA informed on the progress made in clearing up the reactor site. The Iraqi authorities have agreed that the inspection will be resumed as soon as the Tamuz reactors and specifically the highly enriched uranium fuel storage is physically accessible. The Secretariat is in contact with the Iraqi authorities on this matter.

Now, I should like to turn to another development which has been the subject of comments in the press and which involves the conduct of a safeguards inspector of the Agency, Mr. Roger Richter. Mr. Richter joined the Agency on 24 February 1978 and was initially attached to the EURATOM Section. Since 16 March 1979, he has been attached to the South and South East Section which covers inter-alia Israel and Iraq, but he was not designated as an inspector for Iraq. He last attended for duty in the Agency's Headquarters on 15 June. On 18 June, a telex was received from him from Washington stating, "I hereby resign my position as nuclear safeguards inspector for the IAEA effective June 16 1981". On the same day, i.e. 18 June, Senator Alan Cranston stated before the United States Senate Foreign Relations Committee that he had "received four revealing internal documents from American sources within the International Atomic Energy Agency" and on 19 June, Mr. Richter appeared before the United States Foreign Relations Committee and testified questioning the effectiveness of the Agency safeguards system in general as devised in connection with NPT and in particular, its effectiveness in detecting clandestine undeclared production of plutonium in the OSIRIS type of research reactor. Prior to that date, he had supplied to the United States Mission in Vienna a document containing confidential safeguards information. An investigation made in the Secretariat indicates that Mr. Richter is guilty of breach of several Staff Regulations and Rules, the most serious violations being of Staff Regulations 1.01, 1.05 and 1.06.

On the basis of the advice I have received from the Director of the Legal Division, I have accordingly on 2 July decided to summarily dismiss Mr. Richter from the Agency's service on grounds of serious misconduct and this decision has been communicated to him by telex, followed by letter.

Apart from the breach of Agency Rules and Regulations, the misconduct of Mr. Richter raises some fundamental issues concerning the security of confidential information received from Member States. I can well appreciate the serious concern of the Member States which I fully share. The confidentiality of information relating to safeguards is basic to the whole philosophy of the Agency's safeguards operation. We have now about 130 inspectors from some 40 countries engaged on inspections in some 50 countries. This is a serious case of unauthorized supply of information and violation of the trust placed in the integrity of a safeguards inspector in his capacity as an international civil servant of the Agency.

I deeply regret this and I have given instructions for an urgent in-depth review of the whole pattern of security and confidentiality of all safeguards material and documentation. I would like to assure the members of the Board that no effort will be spared to ensure that in our safeguards security arrangements, as far as humanly and technologically possible, safeguards confidentiality is fully preserved. I hope that this singular episode of misconduct would not give rise to a new strain in the acceptance by Member States of safeguards inspectors on grounds of nationality and further complicate the process of designation of safeguards inspectors in future.

May I now invite the Board's attention to my statement of 12 June, in which I indicated that in a research reactor of the OSIRIS type two diversion strategies are technically possible and have to be countered in the safeguards measures adopted.

The first involves removing fuel elements and extracting the highly enriched uranium. The necessary measures to counter this strategy consist of item counting and identification and measurement of the enrichment of the fuel. The safeguards inspections at the Iraqi Nuclear Research Centre, which have taken place up to now have implemented exactly this approach. This inspection frequency chosen is adequate during the period before the reactor comes into operation and the amount of highly enriched uranium on site is less than one significant quantity (25 Kg highly enriched uranium). In accordance with the facility attachment worked out in the autumn 1980, the Agency would increase the inspection frequency as necessary when the amount of enriched uranium exceeds one significant quantity.

The second possible diversion strategy is based on the undeclared production of plutonium by means of neutrons from the core of the reactor. Production of a significant quantity of plutonium (8 Kg) would require the introduction of considerable amounts of natural or depleted uranium into the reactor in form of fertile elements. Further, the use of a research reactor of this type for plutonium production would call for operation of the reactor at full power over sustained periods of time.

The safeguards measures necessary to counter this diversion strategy must focus on detecting fertile materials within and around the core and on the mode of operation of the reactor. The first anomaly would be detected by visual observation supported by optical surveillance in the absence of inspectors and, if necessary, measurements. Frequent refuelling with highly enriched fuel would easily be established by accountancy and would depend on additional fuel supply. It would also become known to the inspectorate in advance through notification by the supplier.

The arrangements necessary to implement these measures have been foreseen in the relevant draft facility attachment and in the normal course, would have been applied when the reactor went into operation. That is to say, with the commencement of the operation, the reactor would become subject to a more rigorous inspection regime with more intensive inspection and safeguards measures being applied as appropriate to the operational mode. One must keep in mind the two distinct stages, namely, pre-operational and the operational.

There was thus nothing wrong with the safeguards being applied on the Tamuz reactors nor any deficiencies in the inspection schedule or procedures. One should also bear in mind that, in this particular case, there is the additional factor of the precautionary measures taken also by the supplier of the plant for its safety.

It was with these considerations in mind that I was able to inform the Board, on 12 June, that in a reactor of this type, diversion of fuel elements or of undeclared plutonium production would be detected with very high degree of probability.

The Agency's safeguards system is being constantly reviewed and upgraded. The Safeguards Implementation Report which was considered by the Board last month analyzed in some detail particular problem areas. They involve the implementation of safeguards by the Agency, cooperation by Member States and operators in implementing safeguards, and the resources required for the continued development and effective implementation of our safeguards system. The Agency will do its best to secure the effectiveness of the safeguards system; however, the continued support of the Board and Member States is indispensable for the success of these efforts.

The incident in Baghdad prompts us to reconsider an important question of principle, viz. are there certain areas of scientific or technical research and development for the peaceful uses of nuclear energy which Member States are not supposed to include in their programmes? I refer in this connection to Article III A, Paras 1 - 4 of the Agency's Statute reading as follows:

> "A. The Agency is authorized:
>
> 1. To encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world; and, if requested to do so, to act as an intermediary for the purposes of securing the performance of services or the supplying of materials, equipment, or facilities by one member of the Agency for another; and to perform any operation or service useful in research on, or development or practical application of, atomic energy for peaceful purposes;
>
> 2. To make provision, in accordance with this Statute, for materials, services, equipment, and facilities to meet the needs of research on, and development and practical application of, atomic energy for peaceful purposes, including the production of electric power, with due consideration for the needs of the under-developed areas of the world;
>
> 3. To foster the exchange of scientific and technical information on peaceful uses of atomic energy;
>
> 4. To encourage the exchange and training of scientists and experts in the field of peaceful uses of atomic energy."

and to Article IV, paras 1 and 2, in the Non-Proliferation Treaty reading:

> "1. Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear enregy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty.
>
> 2. All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also co-operate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world."

Both the Agency's Statute and NPT are clear on this point and presuppose the establishment and administration of safeguards to ensure that military purposes are not furthered and that, at the same time, economic and technological development in the field of peaceful nuclear activities is not hampered.

There is a well known saying that knowledge - once given away - cannot be retracted. Attempts to exclude certain areas of research and development has a way of inevitably attracting increased interest in the same areas. We have a classical example of this in the short history of atomic energy, namely, the methods and technologies used for the separation of uranium isotopes. The secrets of these methods and associated technical details which have been strictly guarded over the years have become the object of a constant and vivid interest leading, as we know, to new methods being developed independently in several countries, and resulting in even commercial organizations being set up to market the products.

I draw your attention particularly to this because I am afraid that following the Baghdad incident, there may be renewed attempts to impose new restrictions and constraints on certain areas of peaceful nuclear technology with a view to preserving them exclusively for certain countries.

I am personally convinced that the right attitude is that the Member States and the Agency should continue - and I quote the Statute again - Article III, A, 1 "to encourage and assist research in and the development and practical application of atomic energy for peaceful uses throughout the world", at the same time, of course, applying appropriate safeguards. This also underlines that it is of fundamental importance to reach as soon as possible a universal acceptance of the NPT or the concept of "full scope safeguards" and to further strengthen the Agency's safeguards.

This, in my view, is a correct and far-sighted approach rather than applying new measures of restrictions and denial - much less resorting to military action.

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International safeguards

Safeguards and non-proliferation: geography, prospects, problems

by D.A.V. Fischer*

A few years ago it looked as though we were nearing the end of the NPT line and that few, if any, further accessions to the Treaty could be expected. The countries that had chosen not to join it were in areas of political tension, or had set themselves against the Treaty for reasons of principle, or were simply not showing any interest in it.

This pessimism proved unfounded. During the last two years several important countries have acceded to the Treaty. Significantly they are all developing countries: Bangladesh, Barbados, Egypt, Indonesia, Sri Lanka, and Turkey. At least three are in regions in which there has been repeated armed conflict since the Second World War. Their willingness to forego nuclear weapons and accept full-scope safeguards is all the more important.

When a country accedes to the NPT it must (except in the case of a nuclear-weapon State) conclude a safeguards agreement within eighteen months of its accession (Article III.4). During the last two years several such agreements have indeed entered into force, for instance, with Indonesia, Libya, Senegal, and Turkey.

As a result there is today only one country that is operating a nuclear facility and which has not yet brought the required safeguards agreement into force within the prescribed time. This is Venezuela. However, the only nuclear facility in operation in Venezuela, the RV-1 research reactor, is under IAEA safeguards by virtue of a previous trilateral agreement concluded with Venezuela and the United States in 1968. Thirty-five other countries are also overdue in concluding their safeguards agreements, in twenty-one cases more than ten years overdue. Apart from Venezuela, none of these countries is building or operating any nuclear facility and the absence of an agreement has thus no practical consequences except that, in one case at least, the Agency is not receiving the reports on exports of uranium ore that would be required by the agreement. Moreover, the obligation to conclude a safeguards agreement within the specified time is a legal requirement and should not be disregarded.

Non-NPT safeguards: It should also be noted that one State which was previously listed as a party to the NPT, Viet Nam, has confirmed that it did not become party to the Treaty by succession to the former "Republic of Viet Nam". It has however, placed its only nuclear facility, a small research reactor, under safeguards.

Outside the framework of the NPT there have been a number of important developments. Agreements concluded with Cuba and Spain during the last two years have brought all nuclear facilities in operation, or under construction in these two countries, under the Agency's safeguards (in the case of Spain all but five facilities were already subject to safeguards).

The first agreement which explicitly brought heavy water under safeguards was one concluded with India in 1977. In October this year, Argentina and the Agency signed two agreements to safeguard heavy water from the USSR as well as a heavy-water production plant supplied by Switzerland. This is the first plant of its kind to come under safeguards. These developments

The 36 non-nuclear-weapon States parties to NPT which on 31 December 1980 had not yet complied with Article III.4 of the Treaty stipulating the last date for the entry into force of the safeguards agreement to be concluded with the Agency

Bahamas
Benin
Bolivia
Botswana
Burundi
Central African Republic
Chad
Congo
Democratic Kampuchea
Democratic Yemen
Gabon
Grenada
Guatemala
Guinea-Bissau
Haiti
Ivory Coast
Kenya
Lao People's Democratic Republic
Liberia
Mali
Malta
Nigeria
Panama
Rwanda
San Marino
Sierra Leone
Somalia
Sri Lanka
Syrian Arab Republic
Togo
Tonga
Tunisia
Tuvalu
United Republic of Cameroon
Upper Volta
Venezuela

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have made it necessary to elaborate the technical procedures to be followed in safeguarding heavy-water production plants as well as heavy water itself.

Only twelve countries (other than the nuclear-weapon States) which are operating or building nuclear plants, have not acceded to the NPT. In eight of them, however, all nuclear facilities of which the Agency is aware have been placed under IAEA safeguards (Argentina, Brazil, Chile, Colombia, Cuba, the Democratic People's Republic of Korea, Spain, Viet Nam). They are shown on the map in red. Four countries (India, Israel, Pakistan and South Africa) are reported to be operating or constructing unsafeguarded as well as safeguarded facilities. They are shown in yellow.

Recent agreements with Spain have reduced the number of countries operating unsafeguarded facilities from six in 1979 to four today*. There has not, however, been any indication that any of the four remaining countries is likely to accept safeguards on all its nuclear activities. On the contrary, press reports indicate that the number of unsafeguarded plants in these countries will soon increase. Thus, for instance, South Africa is reported to have started the construction of a small commercial enrichment plant (besides its pilot enrichment plant), while Pakistan is reported to be building a reprocessing plant as well as an enrichment plant.

Perhaps the main question in regard to the four countries having unsafeguarded plants (each capable of producing plutonium or highly enriched uranium – i.e. weapons-grade material) is whether they will continue to refrain from taking (or repeating) the momentous step of testing a nuclear explosive. The prospects for the non-proliferation regime will be profoundly affected by their decisions. In a broader perspective we must remember that no country among the non-nuclear-weapons States has carried out a nuclear explosion since 1974, while the nuclear-weapon States are continuing to carry out about fifty weapon tests each year.

Prospects

NPT: One may hope that the membership of the NPT will continue to grow, although probably rather slowly. The question of Spain's accession will become topical when it joins the Common Market, as it is due to do in 1984. Many African and some Middle Eastern countries have not yet taken any position on the Treaty. None of them have as yet any nuclear facilities, but Algeria is reported to be planning to acquire a research reactor, and countries like Saudi Arabia, Zimbabwe, Angola, and Mozambique may follow suit in the next decade. Adherence to the Treaty by countries that have no nuclear facilities but are important producers of uranium like Niger, and eventually Namibia, would also be significant. Article III.2 of the Treaty requires every party to ensure that IAEA safeguards are applied in relation to all "equipment or material especially designed or prepared for the processing, use, or production of special fissionable material" that they export to any non-nuclear-weapon State. This, of course, also covers exports of yellow-cake.

A widely deplored event which could influence the future of the non-proliferation regime was the bombing on 7 June this year of the Iraqi research reactors. This was the first time that a peaceful nuclear facility became the target of armed attack, and the precedent set is ominous. It is to be hoped that this development will lead nations to call for a further strengthening of safeguards and the non-proliferation regime and will not undermine it. This matter is examined extensively in the article by Mr Gruemm on page 10 of this issue. (See also Dr Eklund's remarks on this matter, reported in Bulletin 23/3, page 3.)

Non-NPT: If the prospects of adherence to the NPT by the four countries having unsafeguarded facilities must still be regarded as remote, the best hope for extending the non-proliferation regime in these cases may lie in regional solutions such as nuclear-weapon-free zones coupled with effective safeguards. Although the regions concerned have much to lose and little to gain from the existing situation, the problems lying in the way of such regional solutions are also formidable.

The situation in Latin America is different and more promising. As we have seen, five countries in Latin America that are operating or building nuclear facilities (Argentina, Brazil, Chile, Colombia and Cuba) have chosen so far to remain outside the NPT, offering in most cases reasons of principle for the decision. They have nevertheless placed all their known nuclear plants under IAEA safeguards. The alternative route which the Tlatelolco Treaty* offers for a binding extension of the non-proliferation regime thus becomes all the more important, and one of the countries (Colombia) has already followed it by concluding a safeguards agreement according to the Treaty.

Latin America is the only region in the world free from the burden of nuclear weapons (and of the technologically indistinguishable peaceful nuclear explosives); and the only region in which no nuclear explosion has ever been carried out. It is also the only region in which all nuclear facilities (as far as the IAEA is aware) are already under IAEA safeguards**. This unique advantage could be made permanent and binding if four Latin American States were to bring the Tlatelolco Treaty into full operation, as eighteen of their sister nations have already done. The main remaining difficulty preventing the full operation of the Tlatelolco Treaty turns on the question of whether it permits its parties to produce and test their own nuclear explosives "for peaceful purposes", the so-called "PNEs".

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* Assuming that the research reactor in Egypt will shortly be brought under safeguards when the recently concluded NPT safeguards agreement between Egypt and the Agency comes into force.

* The Treaty for the Prohibition of Nuclear Weapons in Latin America.

** If Oceania is regarded as a separate region, it also enjoys this distinction.

There have been several events since the conclusion of the Tlatelolco Treaty in 1967 which may make the path to its full application somewhat easier. In the first place PNEs themselves have lost the lustre they enjoyed at that time, when false hopes were raised about their utility in digging canals, building harbours, developing gas and oil wells, and other major engineering works. Moreover since 1972 two of the main Latin American countries concerned have embarked on major nuclear energy programmes whose implementation would certainly be jeopardized by the construction of unsafeguarded facilities, let alone recourse to PNEs.

Finally, co-operation in the nuclear field between the countries concerned is rapidly expanding.

In short, during the last decade the economic incentive to use nuclear explosive technology has diminished almost to vanishing point while the incentive in the countries concerned to refrain from developing this technology has steadily increased.

If the Tlatelolco Treaty is fully applied throughout the region it will be because the countries themselves have perceived that it is in their own interest; any external pressure is likely to be counter-productive.

Problems

As the Second NPT Review Conference showed *, the bonds of confidence between the parties that the Treaty should help to forge are hardly strengthened by the lack of progress in nuclear arms control and in particular by the failure of the nuclear-weapon States to reach agreement on a treaty for the prohibition of all nuclear tests. The Conference also showed that most parties are not satisfied with the manner and extent of implementation of Article IV of the Treaty which confirms their "right to participate in" as well as their undertaking to facilitate "the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy" and which places a corresponding obligation on the parties to assist each other and particularly the developing countries. It is to be hoped that the work of the Committee on Assurances of Supply will eventually lead to broad agreement about the ways of implementing this article of the Treaty.

Despite the lack of progress in measures of arms control, the Parties clearly continue to regard the Treaty as serving important national interests and it seems unlikely that there will be any significant withdrawal, particularly since such a step might be interpreted as a decision to embark immediately on a nuclear weapons programme.

Another political problem which impedes the effective application of safeguards is the difficulty the Agency often encounters in designating inspectors. Many countries continue to resist designations on the grounds of the inspector's nationality, or the safeguards policies of the country from which he comes, or on grounds of his linguistic qualifications. Such policies are hardly compatible with the letter or the spirit of the Agency's Statute, and can seriously impede the deployment of the relatively small corps of inspectors drawn from 40 countries.

This is not the place to examine the technical problems encountered in the application of safeguards which are analysed in the Agency's annual "Safeguards Implementation Report" and in Mr Klik's article reproduced on page 15 of this issue of the Bulletin. Although such problems may often make it difficult for the Agency to achieve its technical safeguards "targets", the continuing success of the IAEA's safeguards depends to a greater degree on the political will of the Agency's Member States and of other parties to the NPT to ensure that adequate resources are provided for the safeguards operation, and to ensure that safeguards are effectively and impartially applied.

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* See report in Bulletin 23/1, page 28.

Note: The map to which Mr Fischer refers in his article can be found in the centre pages of this issue of the IAEA Bulletin.

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September 1981

IAEA SAFEGUARDS - STATUS AND PROSPECTS[*/]

Safeguards Aspects of the Tamuz Event

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[*/] Updated version of a lecture given at the INMM Annual Meeting, San Francisco, 13 - 15 July 1981.

Introduction

The present status of IAEA safeguards is primarily the result of events which took place during the last decade. It is the starting point of any analysis of future trends in the field of non-proliferation. The end of the last decade was marked, from the point of view of safeguards and non-proliferation by two events of considerable significance: the INFCE and the Second NPT Review Conference. While the Conference dealt primarily with political issues and INFCE with technical ones, the underlying concerns and trends were common to both. At the risk of oversimplifying the problem I would like to list the conclusions one can draw from the deliberations of these two conferences and from related events:

1. There is dissatisfaction among the "Non-nuclear-weapon" Members of the world community of States with the inability of the super powers to curb vertical proliferation and with what is seen as insufficient enthusiasm in providing for the transfer of nuclear technology.

2. There are no "technical fixes" which can be used as effective means of preventing proliferation.

3. There is a growing tendency for certain States to develop independent fuel cycles, even in cases where the size of the nuclear programme does not justify so doing on purely economic grounds.

4. Safeguards agreements providing for comprehensive IAEA verification of compliance with an undertaking not to use nuclear material for explosive purposes remain the most effective non-proliferation instrument available.

5. As a consequence it is necessary to maintain and strengthen the existing system of non-proliferation undertakings and to increase the effectiveness of international safeguards.

It is these two last conclusions which were reiterated recently in the Board of Governors of the IAEA in the light of an unprecedented event in the history of non-proliferation on which I will dwell in some detail later. It may be useful at this point, however, to briefly review the status of safeguards agreements and their implementation.

Status of Safeguards Agreements

In spite of the problems mentioned the Non-Proliferation Treaty has demonstrated its viability. By August 1981,114 States including three nuclear-weapon States (USA, UK, USSR) had become parties to the NPT. The NPT covered almost all the non-nuclear-weapon States of the industrial world as well as some 70 developing States (see Fig. 1). Additionally, non-NPT safeguards agreements partially or fully covered the nuclear activities in ten States.

The countries of particular relevance to safeguards are of course the 49 non-nuclear-weapon States with significant nuclear activities. According to forecasted nuclear programmes this number is not likely to increase much in the 1980s. Of the 49 States just mentioned 39 adhere to the NPT, including the "no Agreement" case (Egypt) in Fig. 1 which ratified NPT a few months ago. At present there are the ten non-nuclear-weapon States mentioned above which operate nuclear facilities and which still remain outside the Treaty, namely Argentina, Brazil, Chile, Colombia, the People's Democratic Republic of Korea, India, Israel, Pakistan, South Africa and Spain. In six of these countries all significant nuclear activities of which the IAEA is aware, were covered by a series of individual safeguards agreements. Four of the six States are in Latin America and have signed the Treaty of Tlatelolco. The ratification and full application of this Treaty would be one of the major events of non-proliferation policy in the 1980s, establishing the first major region in the world which has foresworn the manufacture of nuclear weapons and in which all nuclear activities are under safeguards.

It is a matter of great concern that there remain four States (India, Israel, Pakistan and South Africa) in which unsafeguarded as well as safeguarded nuclear facilities are in operation or under construction. Such unsafeguarded facilities are or will be capable of producing weapons-grade nuclear material.

With the four exceptions noted, the entire industry outside the NWSs is thus under the safeguards of the IAEA. A most significant development in this area would be the acceptance on the part of the four States mentioned, of full scope safeguards.

Turning to nuclear weapon States, it is known that the United States, the United Kingdom and France offered voluntary safeguards agreements covering selected plants of their non-military fuel cycle, thus indicating, symbolically at least, that safeguarding of the full fuel cycle in highly industrialized non-weapon States should not distort international competition. The agreements with the UK and the USA entered into force in 1978 and in 1980 respectively and implementation has started. The agreement with France entered into force recently. The Agency of course can afford only a few inspectors for this purpose.

Looking ahead to other possible developments of the system of agreements, it is not to be expected in view of the mood of the Second NPT Review Conference that significant changes in objectives of safeguards or in their institutional framework should take place. A certain exception to this statement is perhaps the International Plutonium Storage Study, which is presently being discussed in advisory groups to the IAEA. The system envisaged may become a reality in the not too distant future but on a limited scale. It is therefore clear that the important task before us is to maintain and strengthen the existing system of non-proliferation agreements complemented by international safeguards.

Implementation of Safeguards

In the 1970s, the number of facilities to be safeguarded jumped sharply, both because so many new facilities were being built and because so many more safeguards agreements were being implemented during the last three years of the decade, notably those with the Euratom NNWS and Japan, to name the most important ones from the point of view of added workload in the Agency. It can be expected in the mid-1980s that the workload of the Safeguards Department will approximately level off, with only moderate increases in the number of facilities to be safeguarded, with the reservation that later on unforeseen developments or a new impetus given to world nuclear power programmes may lead to further or faster expansion.

The number of power reactors under safeguards for instance has risen from 10 in 1970 to 126 at the end of 1980 (Fig. 2). The number of bulk handling facilities rose from 4 to 48 (Fig. 3). Fig. 4 shows the growing amount of highly enriched uranium and of plutonium under IAEA safeguards.

Most of the plutonium is in spent fuel from power reactors and therefore can be safeguarded by the use of containment/surveillance measures designed for items of well defined integrity. Only five tonnes of plutonium separated from fission products are presently subject to safeguards; it requires a special approach. Fig. 5 shows the increase of natural and low enriched uranium under safeguards. In 1980 about 1100 inspections were made at more than 500 facilities.

Starting from the figures given it may be forecasted that by 1985 the number of major facilities (excluding those under voluntary agreements with NWS) will have increased to about 440, and to 500 in 1990, while material to be safeguarded will increase from 83 tonnes of Pu to 215 in 1985, and 400 in 1990. The figure for HEU, 11 tonnes in 1980, may decrease if research reactors are converted to use fuel of lower enrichtment.

Reflecting this development, the professional staff of the Department of Safeguards has increased from 54 in 1970 to 206 in 1980 of whom 138 are full-time inspectors. It is expected that this latter number will increase to about 175 in 1985 and probably around 200 in 1990. None of all this can of course be done without money. The Agency's budget for safeguards has increased from approximately one million dollars in 1970, when the NPT entered into force, to approximately five million dollars by the year of the First Review Conference in 1975 and 25 million this year.

The Problem of Resources

Agency safeguards still face two serious difficulties in the area of resources: shortage of qualified staff (particularly inspectors) and, looking ahead, uncertain financing of the purchase of second generation safeguards equipment

a) Manpower

The basic problem of manpower that we have had to face results from a very rapid growth in our workload over the last few years. The expansion of our activities to the countries of the European Community and to Japan has been a significant contribution to this problem. The gap between available trained manpower and the corresponding requirements is nevertheless closing thanks both to a slowing down of the growth of our workload and to the adoption of improved recruitment and training practices. In spite of this, the combination of the adoption at the request of our Member States of an IAEA budgetary policy of zero real growth and of the growing pressure from the developing countries for the Agency to emphasize the technical assistance part of its programme, make for a critical condition which is likely to continue to prevail in respect of safeguards manpower resources. Our response is: careful planning of manpower allocation and in particular concentration of inspector effort on the sensitive parts of the fuel cycle i.e. on facilities handling easily convertible special nuclear material in large quantities.

b) Equipment

It has been repeatedly stated that better and more reliable equipment is needed in order to increase the effectiveness of safeguards. In particular, optical surveillance equipment currently consists mostly of upgraded standard commercial items. Certain difficulties stem from this, and expectations of heavier reliance on C/S measures in the near future must be regarded as premature. On the other hand, comprehensive support programmes have been set up by several Member States, in the first instance by the USA, which have, as part of their goal, the overcoming of these difficulties. The first pieces of C/S equipment developed under these programmes have now arrived and are being tested.

The support programmes have also been active in the field of NDA equipment, and the instruments so far developed are being evaluated and, in some cases, being used for inspection purposes.

Because of the major effort by the Department of Safeguards which will be necessary in connection with utilization of the new equipment resulting from these development programmes, it was considered essential to make a forecast of the scope of utilization, the capital and operating costs and the time-scale. Thanks to the expert who conducted this study, we have now an overview of the next five years which indicates expected levels of expenditure which go far beyond the Agency's possibilities. I hope that we shall be able to find, with the aid of our Member States, ways of financing this equipment.

Safeguards Aspects of the Tamuz Event

It is quite natural that implementation of nuclear material safeguards should not be without problems of a political, technical and economic nature. Such problems were anticipated - even serious situations such as detected diversion or false alarms. Fortunately neither of these latter two problems has occurred. But our imagination did not extend to the anticipation of an event such as the Israeli attack on the Iraq Tamuz research reactor on 7 June 1981. This attack, among other things, focussed attention of the mass media on the effectiveness of Agency safeguards. However, the political aspects of this event and the lack of understanding of the technicalities involved in nuclear material safeguards made it difficult for the mass media to present a balanced picture. As a result, concern has been raised from among the general public and one of the main pillars supporting safeguards, their credibility, has been questioned.

The intention of this article is to set the record straight. Because many details of the situation at the Tamuz facility have already been published, we can in this case go beyond the very tight confidentiality rules, normally protecting safeguards information. At the same time this case may be considered as one example of safeguards planning and implementation in action.

Two days after the Israeli attack the Director General of the Agency told its Board of Governors: "We should remind ourselves that the Agency's safeguards system is a basic element of the Non-Proliferation Treaty. During my long time here, I do not think we have been faced with a more serious question than the implications of the Israeli air attack on the Iraq research reactors. The Agency has inspected them and has not found evidence of any activity not in accordance with the Non-Proliferation Treaty. A non-NPT country has evidently not felt assured by our findings and about our ability to continue to discharge our safeguarding responsibilities effectively. In the interest of its national security it has felt motivated to take military action unilaterally. From a point of principle, one can only conclude that it is the Agency's safeguards regime which has been attacked. Where will this lead us in the future. This is a matter of grave concern which should be pondered well". Responding to this statement the Board of Governors, while condemming the attack, expressed its continued confidence in the Agency's safeguards system.

It has been stated that Iraq had embarked on a nuclear weapons programme utilizing the Tamuz materials testing reactor. Clearly it is not the task of the Agency Inspectorate to speculate about the intentions of States with safeguarded nuclear material or facilities. It cannot exlude the possibility of diversion and must therefore take a priori account of diversion possibilities in all States and in all safeguards situations. Likewise, airport control has to consider all passengers as potential carriers of weapons and cannot afford to exempt well-dressed gentlemen. So we made no exception in the case of Iraq and considered all technical diversion capabilities and possibilities connected with the nuclear material present and expected to be present in Iraq.

The development of a safeguards approach for the Tamuz-1 reactor started, as in other cases, well in advance of the arrival of the first fuel shipment. It was obvious that in the case of a powerful research reactor of the Osiris type (Fig. 6)*/, two main diversion strategies have to be considered: first the diversion of highly enriched uranium contained in standard fuel elements and second the diversion of plutonium produced in fertile elements specially manufactured for that purpose.

The Agency believes that the first of these strategies would be effectively countered by the standard Agency approach to pool type reactors. In June 1980 our inspectors were present at the time of arrival of the fuel. The fuel elements were counted, identified and the actual enrichment of the contained uranium was determined. Thus the Inspectorate established an initial inventory of about 12 kg of highly enriched uranium. This is clearly under one significant quantity as defined, and thus diversion of the fuel received could not have led to the production of a nuclear explosive. Taking into account the need to deploy limited manpower resources in the most effective way, it was therefore decided to perform 2 - 3 inspections per year as long as no further fuel elements were shipped to Iraq; such further shipments have in fact not occurred until now. This means that there was and there is no possibility of manufacturing a nuclear explosive by way of diversion strategy 1, and since the reactor has not so far become operational, there has equally been no such possibility by way of diversion strategy 2.

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*/ Fig. 6 represents the Osiris reactor in France and is not classified. Also, other data given in this paper refer to published data on Osiris.

In September 1980 the reactor was the target for an air attack which did little damage. As a consequence, however, military protective measures were taken, such as access restrictions and black-out procedures. The second Agency inspection was made in January 1981, at night and under war conditions. Lighting was adequate, except that where large windows were not covered, only strong flashlights were permitted. The fuel elements stored in a channel under water were satisfactorily identified and accounted for, as was the stored natural and depleted uranium.

In the case of further shipments of fuel elements from France it was planned to increase the frequency of inspections as necessary, to ensure a detection time commensurate with an amount of unirradiated or nearly unirradiated highly enriched uranium in excess of one significant quantity. An inspection every two weeks was envisaged. It was also expected that the French experts and technicians who helped to construct the reactor would remain in Iraq as advisors for several years. They would have remained responsible for the reactor for some time, and would have transferred it to the Iraq government only after a period of operation, by which time the fuel would have become highly radioactive. Since this would have resulted in a longer conversion time, inspection frequency could then perhaps have been decreased somewhat and surveillance measures - tamper proof automatic twin camera systems - installed. The core and spent fuel would have been verified by observation of the Cerenkov glow in order to exclude the presence of dummies.

Diversion of a significant quantity would have required the removal of all or at least a substantial part of the fuel elements present at the facility. It is completely out of the question that such an overt act of diversion, which would have made it impossible for the reactor to operate, would have escaped the attention of Agency inspectors.

Let us now consider in more detail the second diversion strategy, i.e., the undeclared production of plutonium. At the end of 1979, when the Agency was notfied of the transfer of natural and depleted uranium to Iraq, the presence of this material had, according to Article 81 of INFCIRC/153, to be taken into account. Consequently, calculations of the plutonium production capabilities of the reactor were made. Plutonium accumulation in the highly enriched fuel elements is negligible. It was found that the most effective method would require removing the reflector elements and dispersing 15 - 20 fertile elements containing natural or depleted uranium among the core elements. Additionally, the coolant guide-channel containing the core would be surrounded by an external blanket of fertile elements (Fig. 7). Such blanket elements might require additional cooling which could only be provided by introducing conspicuous hardware. Another possibility would be to surround the core with dense arrays of vertical irradiation channels usually present only in small numbers for isotope production; such channels would have to be filled with fertile material. Optimum configurations could lead to a production of about 1 - 2 significant quantities per year. Such production would require a high throughput of fuel - several cores per year - which would.

of necessity become known to the Agency through its inspection activities and from information which France is committed to provide in advance. It is likely that fuel supply would have been interrupted immediately in such a case. Furthermore, Iraq is committed to advise the Agency in advance of the substantial modifications of the reactor necessary for such plutonium production and these would be easily detected by visual observation, the time between inspections being covered by the automatic surveillance cameras. Again we can conclude that production of significant amounts of plutonium in this type of reactor would certainly have been detected and prevented.

It has been claimed that a laboratory located 40 meters below the reactor (the figure was later corrected to 4 meters) which had alledgedly not been discovered by Agency inspectors, could have been used for clandestine plutonium production. This clearly refers to the vault under the reactor which contains the control rod drives (Fig.7). In order to allow access to maintenance personnel, it is heavily shielded at the top by a thick concrete slab which in turn is lined with a heavy steel plate. It is obviously not possible to produce plutonium in this vault.

A rather large beam of neutrons may enter another underground room, a long experimental channel. The plutonium production possibilities however are substantially below those of the arrangement described above. Moreover the capacity of this channel would have been assessed during the Agency design verification prior to the startup of the reactor. If necessary, inspections of the channel would have been arranged.

We can conclude that the very transparent design of the reactor and clear visibility of all substantial changes in its configuration would lead to the swift detection of diversion using either of the strategies.

In view of the information presented, it is not necessary to dwell in detail on statements made by a former inspector who was never actually in Iraq. He had to agree that our approach in respect of diversion strategy 1 was efficient, but claimed that the inspectors would not have been in a position to uncover attempts to follow approach 2, suggesting that the Agency would not have upgraded its safeguards approach after further shipments of fuel. He was careful enough not to mention the necessary drastic and easily observable changes in the reactor configuration and the strong dependence of plutonium production on French fuel supply. He forgot to mention that facilities of all kind not yet submitted to safeguards would have come under safeguards when containing nuclear material and that they are of no use in the present context without plutonium which could only have been produced in Tamuz-1.

It has been argued that Iraq would not have agreed to the upgrading of safeguards foreseen for the time after startup of the reactor. Iraq, however, indicated its willingness to accept any approach under which Tamuz-1 would be treated in a non-discriminatory manner. The approach developed by the Agency for implementation after startup of Tamuz-1 is non-discriminatory because in other cases similar approaches have been accepted by the country concerned and are implemented by the Agency.

In a statement of 6 July 1981, the Director General concluded, after a thorough presentation of the safeguards measures applied and foreseen, that there had been nothing wrong with the safeguards applied to the Tamuz reactors, and that there had not been any deficiencies in the inspection schedule or procedures.

This should also have been clear to those who were concerned about the technical potential of the Tamuz reactor. Was the attack therefore really the result of disbelief in the effectiveness of Agency safeguards?*/

Speculation about motives and intentions is not very productive. However, a lead could be seen in a statement made by the outstanding Israeli physicist Ne'eman in an interview given to the Austrian journal "Wochenpresse". He said: "The mechanism of safeguards is good and reasonable as long as it is respected. The problem is that it can be abrogated unilaterally. Moreover a country can according to Article 10, withdraw from the Treaty at three months notice".

It seems therefore that there is an important lesson to be learnt from this sad episode: we should not only be concerned about the effectiveness of safeguards. Early detection of diversion is only one component of deterrence. It is the consequences which can be anticipated after detection, the sanctions which the Security Council would be expected to apply, which would provide the main deterrent effect. Can the effectiveness of this punitive procedure be compared with the effectiveness of safeguards? This is a serious question which should be pondered well by those responsible.

In respect of the effectiveness of the system of non-proliferation agreements supported by nuclear safeguards, experience so far has been encouraging. In the decade from 1945 to 1954 three States (US, UK and USSR) developed nuclear weapons while only one nuclear power reactor went into operation. In the following decade (1955 - 64) two more nuclear-weapon States emerged (France and China) and another 35 nuclear power reactors were put in operation. Finally, the rate of proliferation has remained zero since 1975 and the number of power reactors in operation has risen to 253.

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*/ If the detection capabilities of the Agency are really perceived as insufficient one has to ask why, e.g., Israel is not prepared to put the Dimona reactor under safeguards

The Agency has been applying its safeguards since 1962 and, so far, there has been no case of any detected anomaly which would indicate diversion of significant amounts of safeguarded nuclear material, or the use of any facility or equipment in the diversion of safeguarded material. This refers today to about 95 % or more of the nuclear material and nuclear facilities outside the nuclear-weapon States.

These considerations strongly suggest that IAEA safeguards have a role to play in shaping the long term prospects for the survival of mankind. International safeguards are the first significant attempt in the history of our restless species to combine agreements on arms control with an objective and effective verification within the territory of the parties in respect of their compliance with the obligations accepted under the agreement. Effective safeguards have not only the obvious advantage of helping to stabilize and limit the current balance of power; they also provide a way of acquiring experience which can be invaluable in the establishment of future more comprehensive means for the achievement of general disarmament. Such general disarmament cannot, after centuries of mutual mistrust among nations, be conceived without controls. We can thus think of international nuclear safeguards as a prelude to general arms control. A further reason to support and strenghthen them.

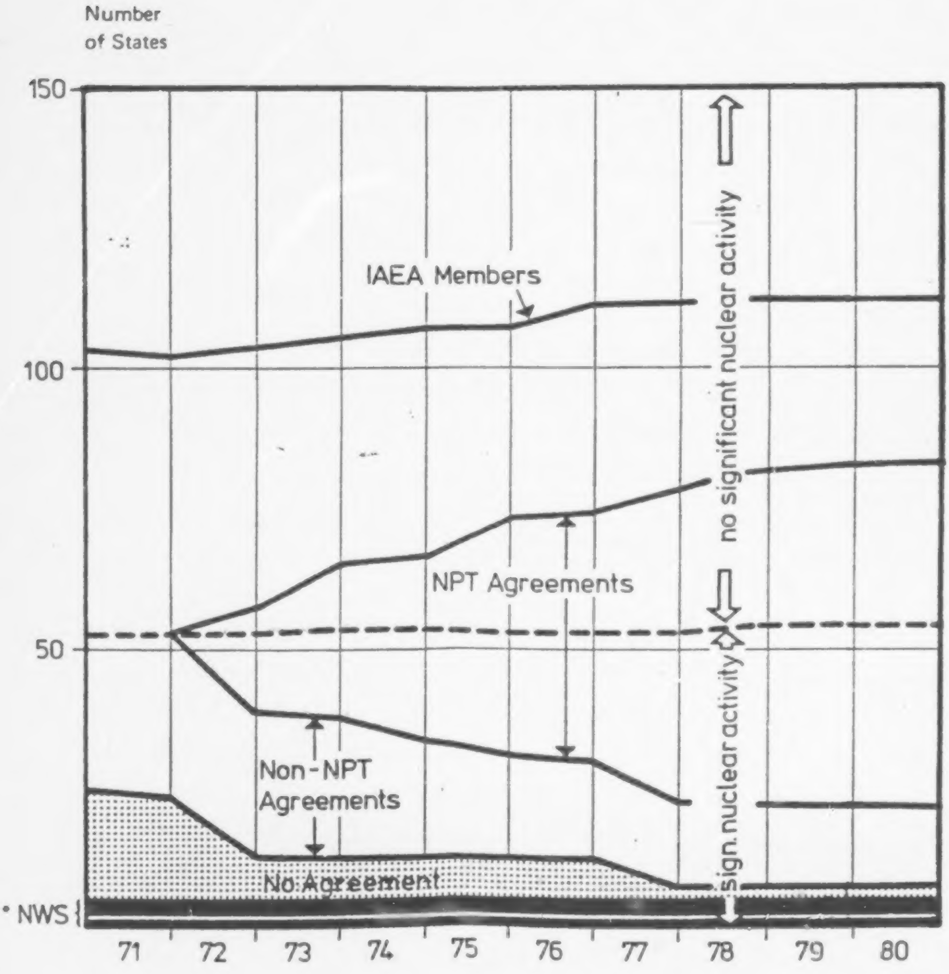


FIG. 1 Evolution of safeguards agreements 1970–1980.

* Three of the five Nuclear-weapon States (NWS) are parties to NPT.

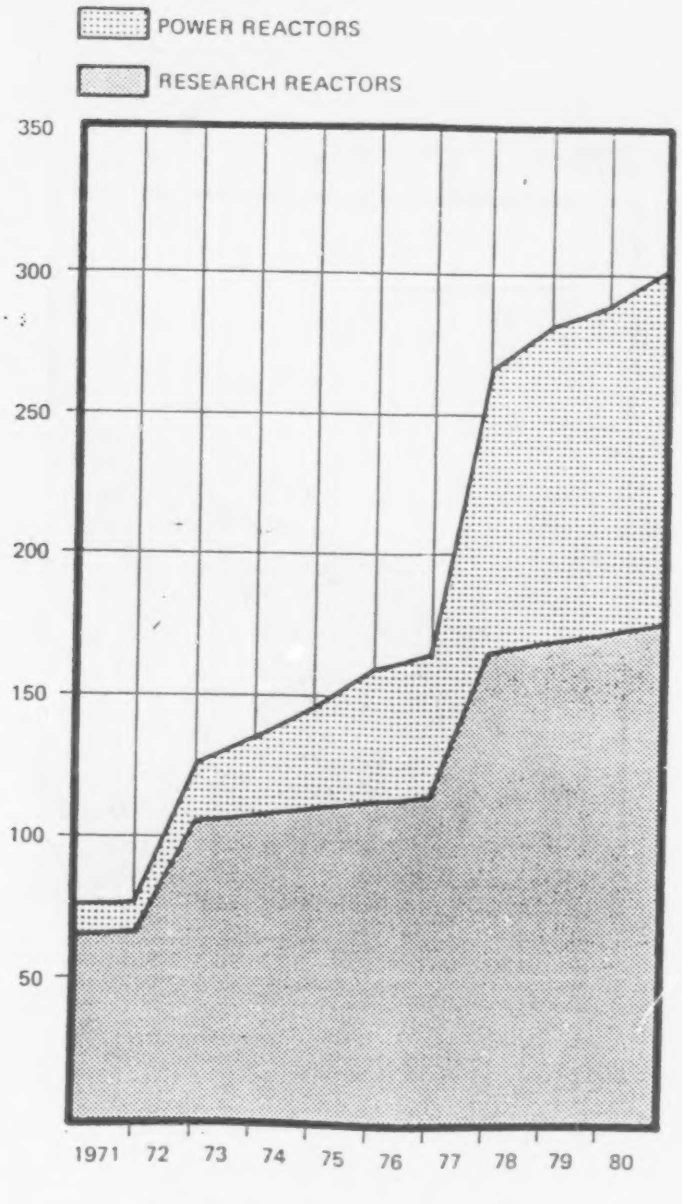


FIG. 2 Number of nuclear reactors under safeguards.

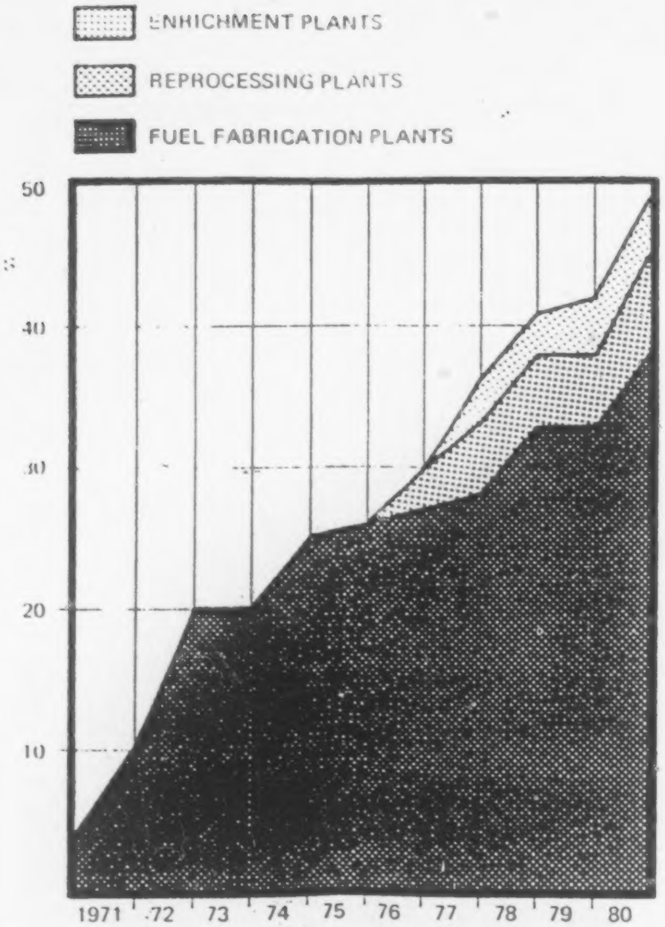


FIG. 3 Number of bulk handling facilities under safeguards.

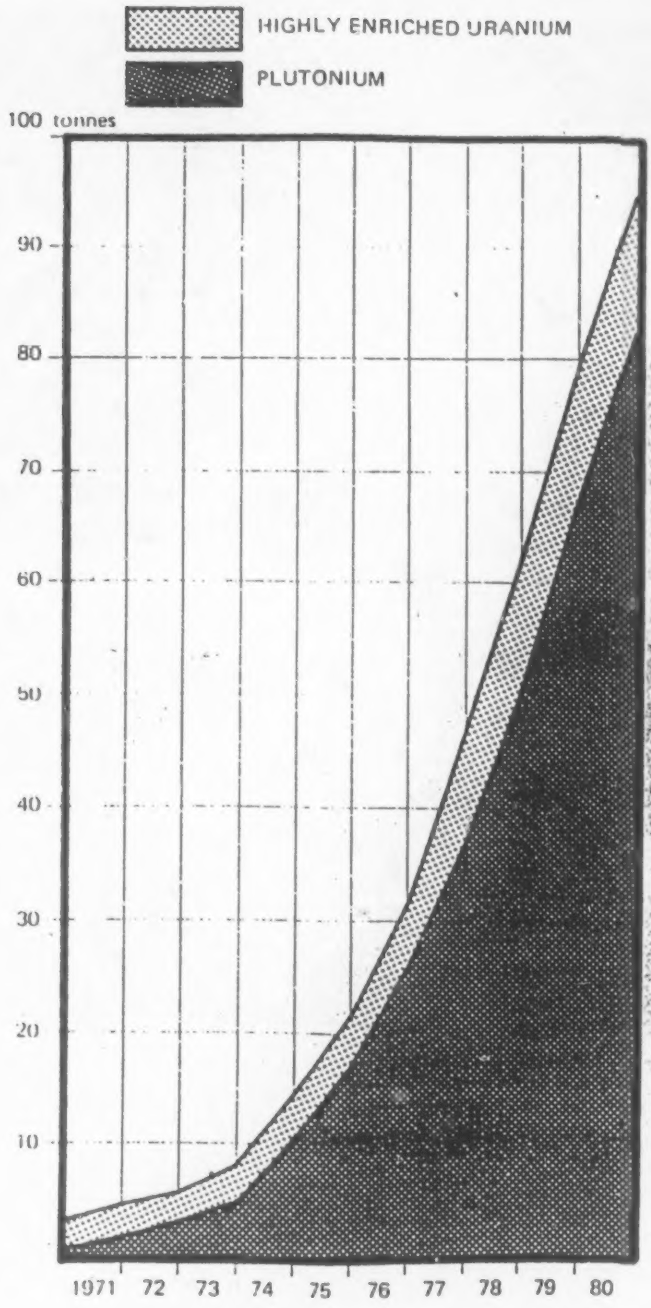


FIG.4. Amounts of plutonium and highly enriched uranium under safeguards.

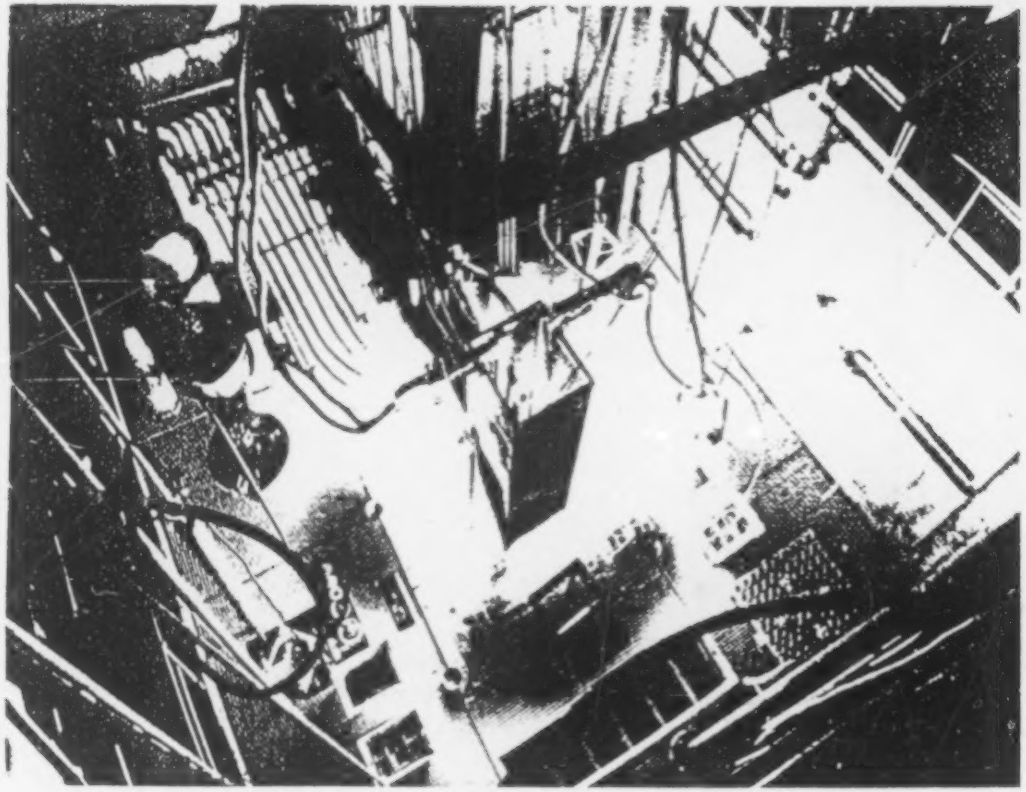


Fig. 6 The photo shows the very transparent arrangement of the OSIRIS research reactor type. The core is located in the rectangular coolant guide channel.

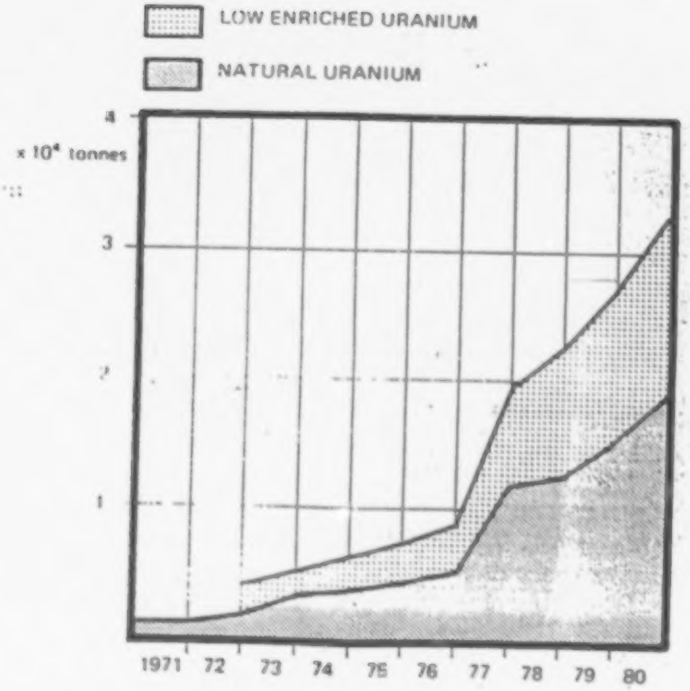


FIG.5. Amounts of natural uranium and low-enriched uranium under safeguards.

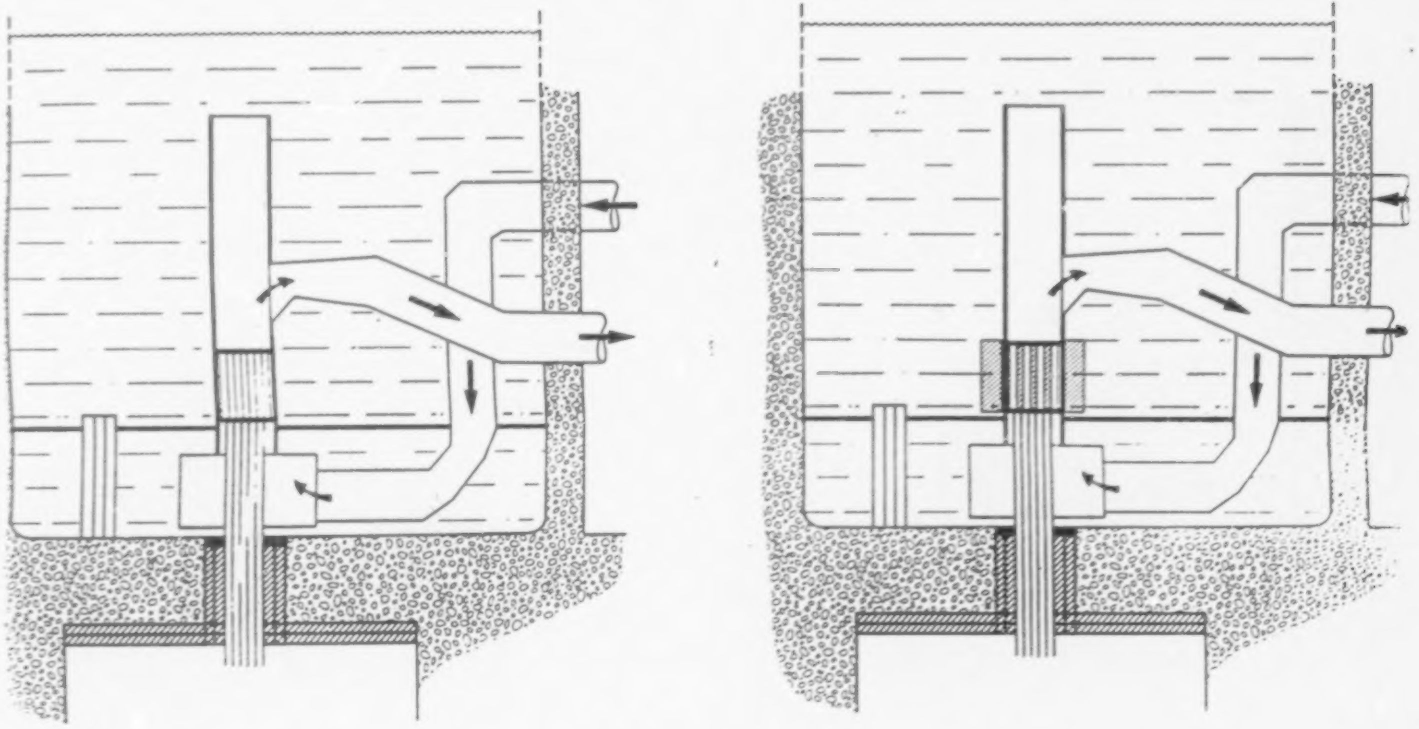


Fig. 7 Vertical section the OSIRIS reactor type. Left : normal arrangement of the core. Right : plutoniumproduction-fertile elements have been inserted in the core and are surrounding the coolant guide channel.

A U.S. Nuclear Regulatory Commission safety analyst considers from an international perspective safeguards necessary to prevent proliferation.

SIDNEY MOGLEWER

IAEA safeguards and non-proliferation

> "The nuclear proliferation problem, as posed, is insoluble. . . . Can conceivable 'safeguards' weaken this stark conclusion? Political arrangements for safeguards must rest on technical measures for materials accounting and for physical security. The former measures are so imprecise and post hoc that they cannot, even in principle, provide reasonable assurance that many bombs' worth of plutonium per year are not being removed from a good-sized reprocessing plant."—Lovins, Lovins, and Ross[1]

The official view of the United States is that acceptance of the Non-Proliferation Treaty and application of the International Atomic Energy Agency's safeguards will provide effective assurance against further proliferation of nuclear weapons. However, because of the ineffectiveness of current IAEA safeguards the view expressed by Lovins, Lovins and Ross is more believable.

The basic approach used by the IAEA for determining the adequacy of safeguards is to evaluate and verify nuclear material accounting information developed by a country at specific facilities. This approach is incorporated into the agreement between the IAEA and the signatories for the Non-Proliferation Treaty.[2] The other document specifying the safeguards system forms the basis for project agreements, transfer agreements and unilateral submission agreements under which equipment, facilities, nuclear material and/or other material and information are subject to safeguards.[3] The IAEA is required to judge in each situation whether the application of its nuclear material verification procedures permits it to fulfill the responsibility of safeguarding facilities, equipment, and material.

The IAEA is responsible for safeguard verification of over 700 facilities. Table 1 presents the number of nuclear installations by category under IAEA safeguards or containing safeguarded material. It is interesting to note the growth of material under IAEA safeguards (see Table 2). There is approximately a fivefold increase over the period from 1974 to 1980. It is apparent that the responsibilities of the International Atomic Energy Agency involve a significant portion of the world's nuclear activities.

The objectives of safeguards are defined to be the

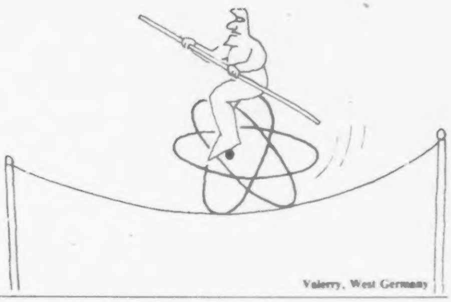
> "timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection."

A *significant quantity* of nuclear material is understood to be the approximate quantity of nuclear material—taking into account any conversion process involved—that the possibility of manufacturing a nuclear explosive device cannot be excluded (see Table 3).

Timeliness results primarily from the frequency of physical inventory-taking; it is evaluated by the IAEA on the basis of conversion time. *Conversion time* is the estimated minimum time required to produce the nuclear components of an explosive device. For materials in direct weapon usable form, such as the metallic state, conversion time is taken as the order of 7 to 10 days whereas conversion times of oxides or other pure compounds of plutonium, uranium-233, or high-enriched uranium are taken as the order of 1 to 3 weeks. The IAEA's timely warning criterion requires that the *detection time* (defined as the maximum elapsed time between an indicated diversion and its detection by IAEA safeguards) be less than the estimated minimum conversion time. Thus, the main objectives of IAEA safeguards are to detect discrepancies in inventories and to deter diversion by providing a timely warning intended to trigger international reaction.

Discrepancies are detected based upon the value of *material unaccounted for* (MUF), which is defined as the difference between book inventory and physical inventory. At any given time, the *book inventory* of material in a material balance area is determined by adding the quantities of material transferred into the area to the initial inventory of record and subtracting from it the quantities transferred out of the area. Periodically a *physical inventory* is taken to determine directly the total quantity of material on inventory.

Due to measurement system errors, biases of unknown magnitude, human errors, unmeasured inventory, unmeasured losses (and possible diversion), the observed MUF contains error terms of a random nature and is generally not zero. Consequently procedures and techniques of statistical inference are required to properly in-



Valerry, West Germany

terpret MUF and should be used in support of decision-making based upon evaluation of unaccounted materials.

Conversion plants, fuel fabrication plants, enrichment plants and chemical reprocessing plants are known as *bulk-handling facilities.* And it is in these facilities that convert and fabricate high-enriched uranium or plutonium, and at this stage of the nuclear fuel cycle, where the material is located from which nuclear weapons or other nuclear explosive devices could most readily be made. Consequently, the IAEA deploys a large part of its total inspection effort on such facilities. IAEA safeguard objectives are based on verifying two physical inventories per year at facilities which convert and fabricate low-enriched uranium and four times per year at facilities which process high-enriched uranium or plutonium (see Table 4).

Evaluation of the effectiveness of the above IAEA safeguards procedures to a large extent can be based upon the data and records of the IAEA. However, the IAEA does not release the data showing the material unaccounted for, plant throughput, measurement uncertainty, inspection results or its judgment concerning safeguards effectiveness for any facility or country. All this information is classified "Safeguards Confidential" and tightly held within IAEA Headquarters in Vienna.

What can be done, however, is to examine IAEA procedures and statistical techniques and relate them to U.S. experience, thus developing a basis for reasonable inference. The statistical framework used by the IAEA has been directly derived from the methods and procedures developed by the Atomic Energy Commission and its successor, the Nuclear Regulatory Commission.

Subsidiary arrangements between the IAEA and the Member State establish such measures as the following, based on a structure of material balance areas:

- a measurement system for the determination of the quantities of nuclear material received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory;
- the evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty;
- procedures for identifying, reviewing, and evaluating differences in shipper/receiver measurements;
- procedures for taking a physical inventory;
- procedures for the evaluation of accumulation of unmeasured inventory and unmeasured losses;
- a system of records and reports showing, for each material balance area, the inventory of nuclear material and the changes in that inventory including receipts into and transfers out of the material balance area;
- provisions to ensure that the accounting procedures and arrangements are being operated correctly; and
- procedures for the provision of certain reports to the Agency.

This is the same *basic* foundation as the domestic safeguards material accounting system employed in the United States and specified in the Code of Federal Regulations, vol. 10, chapter 70. Significant differences of the United States from the IAEA system are:

- designation of facilities (which may contain several material balance areas in the U.S. system) instead of material balance areas [illegible] the basis for the MUF calculation;
- requirements for bimonthly physical inventories for facilities handling high-enriched uranium and plutonium instead of inventory objectives of four times per year;
- establishment of tighter threshold amounts than specified by IAEA (the United States uses 2 kilograms of plutonium and 5 kilograms of high-enriched uranium as trigger quantities);
- more rigid procedures for error modeling and estimation of measurement system uncertainty, including specifying upper bounds (based on facility throughput) for the term "limit of error for inventory differences (LEID)," which is a measure of measurement system uncertainty;
- a post-alarm and plant shutdown criteria; and
- more structured requirements for facility management and control of nuclear materials.

In essence the U.S. system is a tighter system more likely to detect the diversion of a significant quantity of material than the IAEA system. The IAEA Safeguards Technical Manual outlines statistical concepts, techniques, and procedures that are largely based on U.S. experience and techniques.[4] This includes concepts of data structuring and definition, error modeling, and hypothesis testing. The Nuclear Regulatory Commission has recognized that their current system contains serious deficiencies with res-

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pect to the statistical treatment of inventory differences.[5] There are deficiencies for alarm criteria for establishing tests of hypothesis, interpretation of MUF values smaller than the designated alarm, error modeling and definitions. Consequently, the Nuclear Regulatory Commission, unlike the International Atomic Energy Agency, does not rely on MUF (material unaccounted for) analysis for judgments concerning possible diversion. Rather such judgments are primarily based upon other safeguard systems (for example, physical security) and information.

Perhaps the two major deficiencies of the U.S. system are the assumption of the feasibility of a completely measured material balance and the use of a classical statistics approach derived from inanimate quality control considerations for the detection of a diversion or a competitor who is out to take advantage of the system, even fooling it when necessary.

U.S. experience demonstrates the lack of validity of the "completely measured" material balance assumption. For the period April 1974 through December 1978 there were 803 physical inventories conducted at 17 facilities for which LEID (limit of error for inventory differences) was reported. LEID is calculated based upon the measurement uncertainties and should nominally represent the uncertainty component for a 95 percent confidence interval associated with MUF after any recognized bias has been eliminated or its effect accounted for.[6] Actual U.S. experience indicated that there were 375 (out of 803) inventories for which material unaccounted for (in absolute value) was greater than the calculated value of the limit of error for inventory differences (LEID). When there is no loss or diversion, about 40 MUFs would be expected to be larger than LEID. In effect, LEID was not a good measure for MUF variability.

Explanations are easy to find. Assumption of a completely measured material balance does not permit incorporation into the LEID model of non-measurement contributors to MUF variability. These can include unmeasured side streams (such as the stack, sewer, and laundry), process hold-up (material stuck in the pipes), human errors, unrecognized biases, etc. In practice it has not proved possible to obtain a completely measured material balance. Consequently, estimation of the uncertainty of measurements by LEID is not sufficient to characterize the variability of MUF in the absence of diversion. Furthermore, since estimates of non-measurement contributors (which by their nature are statistical estimates, subject to uncertainty) are necessary to characterize MUF, there will always be doubt as to whether these estimates are masking a diversion.

The second major deficiency of the current system is the misuse of the classical statistical test of hypothesis. This test is a one-edged weapon which

Table 1
Nuclear Installations under IAEA Safeguards or Containing Safeguarded Material

Nuclear installation	*End of 1980*[a] *NPT*	*Non-NPT*	*Total*
FACILITIES			
Power reactors	103 (94)	24 (23)	127 (117)
Research reactors and critical assemblies	147 (140)	28 (31)	175 (171)
Conversion plants	3 (4)	1 (0)	4 (4)
Fuel fabrication plants	31 (28)	7 (5)	38 (33)
Reprocessing plants	[illegible] (4)	3 (1)	7 (5)
Enrichment plants	4 (4)	0 (0)	4 (4)
Separate storage facilities	15 (14)	6 (5)	21 (19)
Other facilities	40 (40)	0 (0)	40 (40)
Subtotal	347 (328)	69 (65)	416 (393)
OTHER LOCATIONS	340 (289)	18 (18)	358 (307)
Total	687 (617)	87 (83)	774 (700)

Source: 1980 Annual Report of the IAEA.

[a]The figures in parentheses indicate the status at the end of 1979.

Table 2
Quantities of Nuclear Material under IAEA Safeguards in Non-Nuclear Wespon States[a]
(in tons)

	1975	*1976*	*1977*	*1978*	*1979*	*1980*
Plutonium						
separated	2	3	6	7	8	5[b]
in irradiated fuel	15	23	30	44	60	78[b]
total	17	26	36	51	68	83
Uranium						
enriched to 20 percent or more	4	5	11	11	11	11
enriched to less than 20 percent	3,091	3,613	7,849	10,495	11,714	13,872[b]
Source materials (natural or depleted uranium and thorium)	4,440	5,336	12,234	13,150	15,399	19,097

Source: 1980 Annual Report of the IAEA.

[a]Except that covered by agreements implementing the voluntary offers of two nuclear-weapon states. The table includes all other nuclear material safeguarded under agreements concluded pursuant to NPT (other than material referred to in sub-paragraphs 34(a) and (b) of INFCIRC/153) and all nuclear material safeguarded under agreements concluded pursuant to INFCIRC/66/REV.2.

[b]In one nuclear-weapon state, irradiated fuel has again been placed under safeguards instead of separated plutonium that had been temporarily substituted for it.

Because of the poor technological basis for safeguards material accounting, statements by the IAEA on the effectiveness of safeguards are not supportable and dangerously misleading to the world.

NUCLEAR UMBRELLA

Duncan, England

Table 4

Bulk-handling Facilities under IAEA Safeguards in 1979.

Conversion plants, fuel fabrication plants, enrichment plants and chemical reprocessing plants and pilot plants with an annual throughput or inventory exceeding one effective kilogram.

Country	*Abbreviated name*	*Location*	*Type*
Argentina	Pilot Fuel Fabrication Plant (natural uranium)	Constituyentes	Fuel fabrication
	Pilot Fuel Fabrication Plant (HEU)	Constituyentes	Fuel fabrication
	Atucha Fuel Fabrication Plant	Ezeiza	Fuel fabrication
Belgium	FBFC	Dessel	Fuel fabrication
	Belgonucleaire-BN-MOX	Dessel	Fuel fabrication
Brazil	Resende Fuel Fabrication Plant	Resende	Fuel fabrication
Canada	ENL Port Hope	Port Hope	Conversion
	ENL Port Hope	Port Hope	Conversion
	CGE Peterborough	Peterborough	Fuel fabrication
	Westinghouse Fuel Fabrication Plant	Varennes	Fuel fabrication
	Combustion Engineering Superheat	Moncton, N.B.	Fuel fabrication
	WCL Port Hope	Port Hope	Fuel fabrication
	CGE Toronto	Toronto	Fuel fabrication
	Noranda Met. Ind. Ltd.	Montreal	Fuel fabrication
	ENL Port Hope	Port Hope	Fuel fabrication
	CRNL Fuel Fabrication Plant	Chalk River	Fuel fabrication
	Metallurgy	Chalk River	Fuel fabrication
China, Republic of	INER Fuel Fabrication Plant	Lung Tan	Fuel fabrication
	INER Uranium Conversion Pilot Plant	Lung Tan	Conversion
Denmark	Metallurgy Department	Risø	Fuel fabrication
Germany, Federal Republic of	ALKEM	Wolfgang, Hanau	Fuel fabrication
	NUKEM	Wolfgang, Hanau	Fuel fabrication
	RBU-1	Wolfgang, Hanau	Fuel fabrication
	RBU-2	Karlstein	Fuel fabrication
	GWK-WAK	Leopoldshafen, Karlsruhe	Reprocessing
	Exxon	Lingen	Fuel fabrication
	Uranit	Jülich	Enrichment
India	Nuclear Fuel Complex	Hyderabad	Fuel fabrication
	PREFRE	Tarapur	Reprocessing
Italy	Fabnuc-Bosco Marengo	Alessandria	Fuel fabrication
	COREN	Saluggia	Fuel fabrication
	EUREX	Saluggia	Reprocessing
	IFEC	Saluggia	Fuel fabrication
	ITREC-Trisala	Rotondella	Reprocessing
	Comb. Nuc.	Rotondella	Fuel fabrication
Japan	PNC Reprocessing Plant	Tokai-Mura	Reprocessing
	NFI (Kumatori-1)	Kumatori, Osaka	Fuel fabrication
	SMM (Tokai-1)	Tokai-Mura	Conversion
	JNF	Yokosuka	Fuel fabrication
	MNF	Tokai-Mura	Fuel fabrication
	NFI (Tokai R&D)	Tokai-Mura	Fuel fabrication
	NFI (Tokai-1)	Tokai-Mura	Fuel fabrication
	PPFF	Tokai-Mura	Fuel fabrication
	MAPI	Ohmiya	Fuel fabrication
	NFI (Kumatori-2)	Kumatori, Osaka	Fuel fabrication
	NFI (Takayama-R&D)	Takayama	Conversion
	PNC Pilot Enrichment Plant	Ningyo	Enrichment
Netherlands	URENCO	Almelo	Enrichment
	Ultra-Centrifuge	Almelo	Enrichment
Spain	Metallurgical Plant	Madrid	Fuel fabrication
	Juan Vigon Research Center		
	Juan Vigon Research Center	Madrid	Reprocessing
Sweden	ASEA-ATOM	Västerås	Fuel fabrication
United Kingdom	PFR Reprocessing Plant	Dounreay	Reprocessing

Table 3

The Amount and Quantity of Special Nuclear Material Needed for a Nuclear Explosive Device

Material	*Threshold amount (kilograms)*	*Significant quantity (kilograms)*
plutonium-239 (> 95 percent)	8	8
uranium-233 (isotope)	8	8
uranium-235 (> 90 percent)	25	
uranium-235 (≥ 20 percent)		25[a]
uranium-235 (< 20 percent)		75[b]

[a] High-enriched uranium.
[b] Low-enriched uranium.

The deficiencies of IAEA safeguards stem largely from the fact that the IAEA combines both the functions of a promotional agency and a regulator.

can be used for discrediting hypotheses but not for confirming them. The null hypothesis is usually stated as an assertion that the true value of MUF is zero. The test rejects this hypothesis if the hypothesis is incompatible with the evidence (that is, the observed MUF is larger than the alarm threshold used in the statistical test). If the evidence is not incompatible with the null hypothesis (that is, the observed MUF is below the threshold), then the test is inconclusive. It is not correct to assume that no diversion has taken place for MUF values below the threshold.

That this is misunderstood is indicated by the statement of David Fischer, Assistant Director General of the IAEA: "In other words, the cardinal object of safeguards is to give assurance of the *absence* of diversion, to give assurance that the safeguarded state is not steadily diverting material for use in an emergency."[7] Fischer is explicitly accepting the null hypothesis by this statement. If the object of IAEA safeguards is to give assurance of the absence of diversion, its material accounting framework is based upon an inappropriate model.

Unfortunately the entire framework of classical statistics does not incorporate interaction with a diverter and possibilities available to him for foiling the system. For instance, if the diverter knew the value of the alarm threshold and the characteristics of the MUF statistical behavior, he could use this information to mask his diversions. Perhaps concepts of game theory could be used to eliminate such deficiencies, but this has yet to be done.

In effect, in the absence of specific data from the IAEA, it is a reasonable inference that the present use of the material accounting framework (MUF) as a measure of effectiveness for detecting diversion is highly questionable. Other major questions for the IAEA system can be raised with respect to the threshold amounts. Although specific information concerning requirements for nuclear explosive devices is classified, should not the IAEA be concerned with terrorist weapons? In the modern world terrorists operate on an international scale. If so, should not the IAEA threshold amounts approach more closely the NRC trigger quantities? Or is the U.S. system unreasonably conservative? In any event, there are questions.

In addition the timeliness criteria is not being met by the present system of periodic material balances. Conversion as specified by the IAEA is much shorter than the frequency of inventory taking, data processing and evaluation, and reporting to the IAEA. Undoubtedly the IAEA is acutely aware of this particular problem. This is the rationale for their interim facility inspections between inventories. Suggestions for dynamic material control systems, some of which are in a developmental phase, may do much to alleviate the timeliness problem. However, in a competitive environment with possible diversion, we should not be sanguine about such a system to solve the requirements for assurance that diversion has not taken place. In fact, there may be a sort of Heisenberg uncertainty principle operating – the more timely the information, the less valid the assurance.

Specifically, in a competitive environment, dynamic systems (that is, process monitoring and control) possibly provide a wealth of information to a diverter as well as the agency. Furthermore, being on-line and operating continuously, they give numerous opportunities to a diverter to play his game. The high technology solution proposed by such systems should be viewed skeptically until sufficiently verified by operational testing in an objective manner.

There are other specific criticisms of the IAEA safeguards system that have been made by others. These largely are based upon IAEA resources and specific operational procedures (that is, number of inspectors, inspection plan, and procedures). However, no matter how good the procedures and how large the resources, if the theoretical bases upon which the IAEA is operating are questionable, then the effectiveness of safeguards are also questionable.

To the detriment of national decision-making, the IAEA has officially not recognized its limited safeguards capabilities. Its annual reports state that:

> "the Secretariat in carrying out the safeguards program of the Agency, did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material – or the misuse of facilities or equipment under certain agreements – for the manufacture of any nuclear weapon, or to further any other military purpose, or of the report which the Director General submitted to the Board on the implementation of safeguards, . . .it is reasonable to conclude again that nuclear material under IAEA safeguards remained in peaceful nuclear activities or was otherwise adequately accounted for."

The deficiencies of IAEA safeguards stem largely from the fact that the IAEA combines both the functions of a promotional agency and a regulator, certainly an unhealthy situation. The collegial environment within the IAEA does not promote independent and even-handed regulation. The promotional side of the IAEA encourages the treatment of all participating countries as benign. This creates a large potential for cheating and unauthorized diversion. Because of the poor technological basis for safeguards material accounting, statements by the IAEA on the effectiveness of safeguards are not supportable and dangerously misleading to the world. In essence, the IAEA safeguards have serious procedural deficiencies and the IAEA lacks adequate resources for its responsibilities.

The relationship of the United States to the IAEA over the years has been close. Over half of its funding comes from the United States. And, as has been stated earlier, the basis for IAEA safeguards procedures have been derived from American experience.

Since proliferation remains a serious problem and there is question of IAEA effectiveness, it is essential that the United States rethink its non-proliferation policy. The Atoms for Peace policy actively pursued by the United States has expedited the timetable for world nuclear development – and the dangers of nuclear proliferation. We have not simultaneously provided the world with effective safeguards, however. There is an obligation for the United States to present an honest assessment of safeguards capabilities to the international community. In addition a major program to improve safeguards technology to provide adequate effectiveness – if this is possible – should be undertaken by this nation with results freely presented to the world community. Until and unless we do this, the Lovins, Lovins and Ross view should be seriously addressed. ☐

1. A.B. Lovins, L. Hunter Lovins, and L. Ross, "Nuclear Power and Nuclear Bombs," in *Foreign Affairs*, Summer 1980.
2. International Atomic Energy Agency, *The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, INFCIRC/153 (corrected).
3. IAEA, *The Agency's Safeguards System (1965, As Provisionally Extended in 1966 and 1968)*, INFCIRC/66, Rev. 2, Sept. 16, 1968.
4. IAEA, *IAEA Safeguards Technical Manual*, IAEA-174, 1976.
5. U.S. Nuclear Regulatory Commission, *Report on the Statistical Treatment of Inventory Differences*, Information Report from Executive Director for Operations to the Commissioners, SECY-80-514, Nov. 20, 1980.
6. See Code of Federal Regulations, vol. 10, chap. 70.51.
7. David Fischer, *International Safeguards 1979*, International Consultative Group on Nuclear Energy, September 1979.

LETTERS TO THE EDITOR ON MOGLEWER'S ARTICLE

On IAEA safeguards

Sidney Moglewer (*Bulletin*, Oct. 1981) is harshly critical of International Atomic Energy Agency safeguards because he claims that the system suffers by comparison with the U.S. Nuclear Regulatory Commission system of material accounting. He refers to the Agency as a regulator, with conflicting responsibilities as a promotional agency, and he faults it for, among other things, failure to concern itself with the terrorist threat. His criticisms, if accepted at face value, would have the effect of seriously undermining confidence in the entire system of international safeguards. Moglewer joins an increasing chorus of Agency critics; if they are wrong, it is important to the preservation of the nonproliferation control structure that those criticisms be answered.

Moglewer's views are based on a fundamental misconception of the purposes and functions of the Agency's safeguards – misconceptions shared by too many policymakers, and inadvertently spread on occasion by the Agency itself.

First, let us dispose of some of Moglewer's more clearcut misconceptions. He attributes the alleged deficiencies of Agency safeguards to a conflict between its regulatory and promotional responsibilities. That particular criticism became fashionable a few years ago, when it was directed, with considerable justification, at the U.S. Atomic Energy Commission.

Unlike the Commission, the Agency is neither a regulator nor a promoter. It has no legal authority to impose regulations or to enforce them; that authority is held by the state having jurisdiction. The Agency's safeguards activities are monitoring and auditing, not regulation; and they are subject to voluntary agreements with individual states, negotiated under general, common guidelines. The Agency's other principal function is to provide technical assistance to members in the application of nuclear energy, fulfilling commitments made by advanced-country members and reaffirmed under the Non-Proliferation Treaty. Nothing in either the Agency Statute nor the Treaty indicates that the Agency's responsibility is to "sell" nuclear energy rather than to make technical assistance available when it is asked for. Unlike the potential conflict between regulation and promotion, there is no basis for the charges that the Agency is deliberately lax in carrying out its safeguards responsibilities in order to extend the use of nuclear power. Such charges should be supported by something more substantive than incorrect interpretations of Agency functions and assertions that the "collegial environment" of the Agency is unhealthy.

Moglewer implies that the Agency shows inadequate concern for theft by terrorists. He seems not to understand that the state is responsible for measures to prevent theft by individuals. Throughout, he compares Agency with Nuclear Regulatory Commission (NRC) safeguards. But the system is not a counterpart of the Commission. What are generally referred to as IAEA safeguards are a supranational operational element in a comprehensive system, of which national elements are integral parts. The Agency system provides guidelines for national systems of physical protection and material control. The operational function of "IAEA safeguards" is to audit national records, analyze reported data, and verify records and reports by means of independent measurements and observations. Protection against subnational adversaries and individuals rests with the sovereign authority of the nation, not the Agency.

One of Moglewer's major criticisms centers on the contention that the "timeliness criteria" are not met. The idea that Agency safeguards are ineffective if a diversion cannot be detected and action taken to prevent assembly into a bomb before the material can be converted to bomb-usable forms has been reiterated for so long by nuclear critics that it has been accepted by many as a requirement. The term "timely detection," quoted from the Agency document, has been used by the Agency only to indicate that detection time should be roughly related, *by order of magnitude*, to conversion time; that timeliness is a more important factor, for example, for separated plutonium than for natural uranium.

Timely warning in the sense used by Moglewer has never been recognized by the Agency as a criterion for acceptable performance. The rationale for the necessity of successful intervention before a single bomb could be assembled is more appropriate where subnational theft is a concern than where the purpose is to monitor compliance with international agreements. Agency safeguards include no control or retaliatory means, and it is not credible that responsible action of any kind would be taken within a few days, even with instantaneous detection. If "timely detection" in that sense is a necessary criterion, then no system of materials accounting could meet it: not IAEA, not Euratom, and not the Commission. Such an interpretation arose from confusion between physical protection against terrorists and the monitoring of peaceful uses. Only the latter is the function of Agency safeguards.

The Agency position has been:

> "According to recommendations of highly qualified advisers detection time should be of the order of magnitude of conversion time. Critics stress again that the philosophy of physical protection may have suggested—at least partially—this definition. The physical protection reasoning assumes that detection should be so timely that the diverted material can be recovered before the diverter was able to insert it into a previously prepared explosive device. At the national level such quick action of guards or police against individuals or groups is both necessary and possible. At the international level we have to take into account both the reaction time of political organs and the restricted scope of their sanctions."*

David Fischer, in the paper cited by Moglewer, says that safeguards are not a burglar alarm but a means of providing assurance. Moglewer saw that statement only as evidence that Fischer does not understand the null hypothesis of statistical analysis. Moglewer would have a clearer understanding of safeguards and the problem of proliferation control in general if he would read Fischer's paper with a broader perspective.

Moglewer also finds fault with material-balance accounting as a basis for safeguards, pointing out the problems of measurement error, unmeasured sidestreams and residual uncertainties. But he suggests no solutions, thus implying that analysis of "materials unaccounted for" is at best ineffective and at worst misleading. What would he suggest as an alternative? Fissile materials are obviously essential to weapons-related activities, and verification that all those materials are accounted for is probably the best means of assurance that agreements limiting them to peaceful uses are complied with. It does not follow, however, that because detection capability may be limited at a quantitative threshold of a few kilograms, that material-balance accounting is ineffective.

Rather than set some hypothetical standard for acceptable safeguards in terms of detection performance, which as Moglewer mentions is difficult for the Commission as well to meet, Agency safeguards should be judged in terms more analogous to arms control. Monitoring of compliance by means of on-site inspection is at a primitive stage of development. Safeguards, whatever their technical limitations, are a major advance in international cooperation and confidence. If Moglewer is critical of safeguards because they might not detect diversion of small quantities, what does he expect of systems for monitoring arms-control agreements? If the effort is useless, or worse, what does he advocate?

Because the Agency's safeguards have not met unrealistic expectations of detection performance, many have concluded that Atoms for Peace was a mistake. The corollary is that, if we had continued the previous restrictive policy of secrecy, we could have held nuclear technology within Pandora's box. That naive view ignores the fact that the box was always leaky (the British, Soviet, and French nuclear programs were begun in that era), and it is based on the arrogant assumption that other peoples are not capable of developing their own technology. There was never any escape by unilateral action from the potential dangers of nuclear energy, and there is none now.

Support for the Agency is based on a balance between desire for access to nuclear energy and concern over the potential for weapons use. Safeguards are essential to maintaining that balance. Some countries accept safeguards as a *quid pro quo* for nuclear assistance; others consider them a necessary condition for advancing such assistance. The Non-Proliferation Treaty and the Latin-American Treaty likewise are dependent on these safeguards; loss of confidence will cause the whole structure of proliferation control to collapse. The world has progressed far in international cooperation by the acceptance of international safeguards inspection. We must not allow that progress to be jeopardized by unfounded criticism on narrow technical grounds. The safeguards technical community should apply its efforts, instead, to support of technical assistance by the United States, Canada, and others to improve their effectiveness.

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*Hans Grumm, Deputy Director General, Department of Safeguards, IAEA, in a paper presented at the 21st Annual Meeting of the Institute for Nuclear Materials Management, 1980.

Moglewer seems to think that, in view of what he considers to be fatal weaknesses of Agency safeguards, Lovins, Lovins and Ross offer a suitable fallback alternative. But in the article Moglewer cited, they dismiss the entire problem by proclaiming that the question of nuclear regulation is moot, because when the social revolution that they envision is accomplished, all central power stations will be replaced by such things as backyard biogas generators and windmills.

We do not consider the issue to be moot. We must continue efforts to control the spread of nuclear weapons. The IAEA is not an ineffective police force; rather, it is the most advanced system of international inspection of the internal activities of sovereign states that has ever operated. The purposes of non-proliferation are ill-served if confidence in its safeguards is undermined because they are mistakenly judged.

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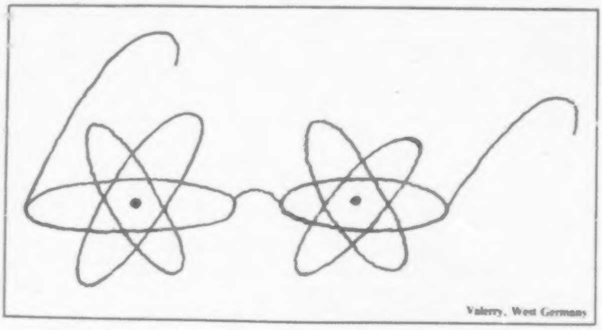

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* * *

Sidney Moglewer quotes me as saying: "In other words, the cardinal object of safeguards is to give assurance of the *absence* of diversion, to give assurance that the safeguarded state is not steadily diverting material for use in an emergency." He then adds: "Fischer is explicity accepting the null hypothesis by this statement."

I was not doing anything of the sort. My intension, which obviously failed, was to make it clear that the main political value of Non-Proliferation Treaty (NPT) safeguards was to provide a reasonable assurance that one's own country was *not* engaged in making nuclear explosives or nuclear weapons, in other words, to demonstrate one's own peaceful commitment and thereby contribute to international security.

The reason I felt it necessary to make this point was that during the late 1970s the main political view of safeguards was widely and, in my view, wrongly held to be that of giving "timely warning" *after* a diversion so that other countries could politically pressure the diverter to dissuade him from detonating the diverted material. This interpretation was very different from that of the architects of the Non-Proliferation Treaty and of the Standard NPT-Safeguards Agreements who emphasized the deterrent effect of safeguards as well as the verification of non-diversion. By the time a diversion takes place (if it ever does), the value of safeguards in providing an international assurance of peaceful commitment and of deterring diversion would obviously have been reduced to zero in the case in question.

It seems that in a recent incident NPT safeguards have failed to provide this assurance to one of the IAEA's member states but this is another question which is dealt with succintly in Anthony Fainberg's article in the same issue.

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* * *

Moglewer's response: To the careful reader the points made in the de Montmollin letter speak for themselves. I quote from the publication *IAEA Safeguards, An Introduction* IAEA/SG/INF/3 (IAEA, Vienna, 1981):

"Deterrence is aimed at dissuading any state that might contemplate diversion of nuclear materials or the misuse of nuclear facilities. It fol-

> lows that, to constitute an effective deterrent, safeguards must be technically capable [and be seen to be capable] of promptly detecting the diversion. Detection of diversion must also be seen to entail effective penalties for the diverting country."

If one accepts de Montmollin's viewpoint, particularly with respect to a timeliness criteria, the Agency itself has unrealistic expectations of detection performance. Responsible professionals, despite affiliation, have an ethical obligation to present their concerns directly, to persuade the organization to change its safeguards objectives to more realistic goals compatible with technical capability.

I certainly agree with the authors that the International Atomic Energy Agency is the most advanced system of international inspection of the internal activities of sovereign states that has ever operated. I also believe that there is serious question of Agency effectiveness. That is the problem.

Fischer presents an interesting interpretation of the meaning of safeguards assurance—"to provide a reasonable assurance that one's own country was *not* engaged in making nuclear explosives or nuclear weapons, . . ." Again I quote from the publication *IAEA Safeguards: An Introduction*:

> "Safeguards are essentially a technical means of verifying the fulfillment of political obligations undertaken by States in concluding international agreements relating to the peaceful uses of nuclear energy.
>
> The main political objectives of safeguards are:
>
> - To assure the international community that States are complying with their non-proliferation and other 'peaceful use' undertakings;
> - To deter (a) the diversion of safeguarded nuclear materials to the production of nuclear explosives or for other military purposes and (b) the misuse of safeguarded facilities with the aim of producing unsafeguarded nuclear material.
>
> In view of the voluntary nature of this acceptance of safeguards, and for other reasons, it is reasonable to expect that the normal results of applying safeguards will be to confirm that there has in fact not been any diversion. Confirmation that this is so results from independent verification by the IAEA inspectorate. The assurance thus obtained from the IAEA's activities as an independent and objective auditor increases confidence between States and helps to diminish political insecurity which is normally the main motivation for acquiring nuclear weapons."

It would appear that Fischer's view of the nature of assurance differs significantly from that of the International Atomic Energy Agency.

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COMMENTS ON IAEA SAFEGUARDS

by
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August 1981

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Introduction

Since my retirement as Director for Field Operations of Safeguards for the International Atomic Energy Agency in 1977, I frequently have expressed my views on the great importance of these safeguards and on some regrettable shortcomings, their causes and possible remedies. These matters were developed in my report to the Congressional Research Service in 1978. It is disappointing to note that since then the pace of needed improvements has been slow, at times almost glacial. My present purpose is to bring my earlier comments up to date in the following overview of IAEA safeguards.

Much of the difficulties with IAEA safeguards, in my experience, has derived from the U.S. policy and practice of adapting its actions affecting safeguards to circumstances of the moment rather than holding to principle, and to a clumsy implementation of policy. Dispassionate reasoning should be the proper way to face a situation. Yet a common characteristic of the super powers and Agency's bureaucracy is their unwillingness to face disagreeable facts. Instead, they prefer nirvana. But, as always, the facts will speak for themselves. Thus, in the following comments I address IAEA safeguards in medias res with special attention to their application in Euratom and Japan, the inadequacy of verification tools and measures; problems of IAEA inspectors and use of their reports; abuse of confidentiality of IAEA safeguards information, biased information about performance of safeguards; improvements needed in safeguards systems and organization; difficulties caused by political and bureaucratic inertia, discrimination in implementation; myopic tactics and vascillation of nuclear-weapons states, and some closely related matters that demand promote attention and action.

IAEA safeguards: their adequacy and problems

The adequacy of IAEA safeguards.--Based on my direction of IAEA's safeguards operations for many years, I was among the first to grasp the nettle of their adequacy. As early as 1966, 1/ I concluded that the IAEA was not able to safeguard adequately. This was a serious conclusion which was regarded as virtual heresey. A number of my internal reports developed this point, particularly in the years 1969 to 1977. 2/ In my view, IAEA safeguards were inadequate because they did not sufficiently and efficiently use inspection rights available under safeguards agreements, they relied too much on an intelligence type approach and too little upon use of sophisticated technology and the cooperation of safeguarded states; and information about them was overclassified by a self-centered bureaucracy. The latter was fatal for improvement that could have followed critical analysis of safeguards.

The character of matters at issue is prevailingly political. This is of paramount importance because the whole idea of non-proliferation is based on voluntary adherance to commitments subject to international verification through cooperation. This cooperation ought to be imbued with the mutual frankness between the Agency and the safeguarded states, and reciprocal regard between the nuclear-weapons states and the non-nuclear weapons member states. A problem is the wisdom of combining promotional and safeguards activities in one enterprise. The great majority of the member states favor priority of promotional activity, while the nuclear weapon states push safeguards. 3/ As a consequence, both activities suffer.

1/ See references 1 and 17.

2/ See references 2, 3, 7-9, 13-25, 41, 53.

3/ See reference 11.

It goes without saying that it it can be fatal for the future of safeguards to underestimate the importance of these voluntary undertakings and their ability to work satisfactorily through faithful cooperation between the IAEA and the states involved. Through such cooperation, a State under safeguards makes available all data about its adherence to non-proliferation commitments and permits the Agency inspectors to verify such data quantitatively by physical means to show whether an unauthorized removal of nuclear material has been detected. Continual verification through such cooperation is crucial. While it is generally known that not even a perfect verification system could prevent a determined State from diverting nuclear materials to illicit purposes, if IAEA safeguards can provide timely warning, then such diversion can be deterred by the risk to the State of discovery, exposure, and possible countermeasures before an illicit activity gets past the "point of no return"!

Contributing mistakes.--Many political and technological mistakes were made during the last decade that have affected safeguards. Some derived from incompetence of the IAEA bureaucracy, others were caused by influence and conflicting interests of the super powers. These have seriously injured credibility of IAEA safeguards. Even today the Agency lacks a long-term and steadfast policy for safeguards, causing concern and mistrust by many states.

The United States, as a major world supplier of nuclear assistance, has a great interest in strengthening IAEA safeguards. Unfortunately, it has tended to make unjustified compromises on policy. When short- and long-term interests have conflicted, the long-term interests have faded from sight. Similarly, within the IAEA secretariat, decisions affecting safeguards have been unduly influenced by expediency.

U.S.-Soviet influence.--Unfortunately, the United States and the Soviet Union have tended to treat the IAEA as their monopoly and as a trading place for their interests. Their fundamental assumption that together they can determine the course and pace of proliferation is both fallacious and dangerous. Moreover, the skill of the Soviets in their manipulations within the Agency conditioned by the bureaucracy's personal advantage policy, 4/ the American "fifty-fifty" approach and the indetermination of non-nuclear weapons States, have led to a semi-sovietizing of safeguards. However, to press the Soviets to submit their facilities to safeguards is misleading and even illusory. Certainly, there is no reasonable way to do without Soviet participation. The Soviets, despite their somewhat misdirected policy toward IAEA, are strong supporters of safeguards, although their goals, strategy, and tactics differ from those of the United States. The fundamental problem is not how to bridge the disagreements between the superpowers by opportunism and unjustified compromises, but rather is how to get them to live with each other within the Agency and to define the common denominators needed to improve IAEA safeguards and to regain world confidence in them. In other words, the problem is a joint one, requiring complementary, but just, actions. The absence of this common sense accounts for some serious mistakes, since an error in policy is usually amplified in practice.

Continuity of knowledge: a fundamental principle.--The creditability of IAEA sageguards requires an enduring effort to achieve continuity of knowledge about safeguarded materials. 5/ This is a fundamental principle. Safeguards

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4/ See references 3, 8, 9.

5/ See references 7, 22, and 24.

without continuity of knowledge about nuclear material, its composition, quantity and location, are senseless.

Third world personnel for safeguards.--Making the IAEA inspectorate "three dimensional" by assigning Third World citizens to supervisory posts would be a wise move. Today citizens of these States do not occupy such posts. 6/ Yet before the super powers secured their monopoly over IAEA safeguards, many Third World States were constructively active and productive in designing the safeguards systems for non-NPT and NPT States during the years 1964 to 1970. The last general conference clearly shows contemporary suspicions and doubts of these states about IAEA safeguards and distribution of posts.

Overclassification of safeguards information.--The Agency's secretariat, in spite of the fact that only specific data for particular facilities under safeguards have to be protected as confidential, treats all safeguards information as confidential. It has classified practically all safeguards information, and uses this classification as a defense against any challenge to its bureaucracy. Consequently, factual and critical accounts of safeguards are barred, 7/ and most Member states remain uninformed of safeguards inadequacies

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6/ See Figure 1 at page 2-37.

7/ The inconsistent focus of bureaucracy in handling safeguards information goes too far, i.e., concerning the inspectors and the superpowers, and, it is also directed at the suppression of criticism related to the administering of safeguards. While inspectors are instructed "not to communicate to any person or government any information known to them by reason of their official position which has not been made public. . ." ect, staff who have left IAEA, including those who worked during many years in the Department of Safeguards have been denied access to present staff. An order by the Director General prohibit visits and discussions to safeguards staff unless approved by the top level bureaucracy. This order discourages critical analyses of safeguards by former staff which could be constructive and useful. As mentioned above, only some industrial and commercial data from particular facilities are really confidential, and these data have no use for analysis of internal IAEA weaknesses. How generous the bureaucracy is in respect to super power access to safeguards data is described on page 13 to 17.

and bureaucratic failures, while the Board of Governors, the Agency's General Conference, and the United Nations are at best only partially informed. More than ever now these policy-making bodies must fully and currently be informed.

It seems most curious to me that the Americans used the confidential nature of safeguards information as an excuse to remain officially ignorant of the inadequacies of the IAEA safeguards system! 8/

The Director General's finding of no diversion.--Perhaps the United States has relied upon intelligence to conform the Director General's 1977 statement, which has special meaning for the large quantities of U.S. supplied nuclear materials abroad, that ". . . there was no diversion in all safeguarded 41 states at all . . ." 9/ The practice of the Director General is to report annually that there has been no diversion of nuclear materials in safeguarded states. Through my years with the IAEA, my inspectors and I tried to convince the secretariat not to make so sweeping a statement because of insufficiently quantified verfications which could not support so sweeping a conclusion. Some facilities that contain strategic nuclear materials still are not yet safeguarded as objectively possible. Nor is the continuity of knowledge for verification assured at many facilities. 10/

As for U.S. knowledge of this situation, I kept the U.S. mission to the Agency continuously and fully informed. In keeping with the Director General's instruction to me of February 2, 1966, when I produced my first critical paper on

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8/ See reference 6.

9/ See references 6, 12, 15.

10/ See references 4-6.

safeguards 11/, I supplied more than two dozen papers on safeguards limitations to the U.S. and Soviet missions and on my own part to other interested missions. The response, unfortunately, was not enough to cause needed improvements in safeguards.

The Director General's reports to the Board of Governors that "there has been no diversion at all" in all safeguarded states or that "nuclear material was adequately accounted for" in my opinion are directly contrary to the IAEA Statute (Articles VII and XII). 12/ IAEA inspectors have never made such unconditional statements. The conclusions drawn by the inspectors indicate a degree of reliability based upon their quantitative measurements. Nevertheless, the Director General has continued to give unconditional assurances of no diversion in spite of my repeated warnings about the limitations of verification. Indeed, I personally informed members of the Board of Governors and representatives of Member States of this situation. The Board of Governors was partially informed of this situation by the bureaucracy only after I had put my warnings into writing.

Obviously I am not implying that diversions must have occured. I am describing what I think is a serious problem with important consequences for IAEA safeguards, one that has resulted from misguided actions by the IAEA management despite extensive efforts of its inspectors to prevent it.

Safeguards agreements with Euratom and Japan.

Problems.--There is general dissatisfaction with the IAEA safeguards agreements with Euratom and Japan. Years after the Board of Governors had approved the Euratom safeguards agreement in 1972, 13/ subsequent negotiations on basic safeguards approaches, and verifications still had not been settled,

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11/ See reference 17.

12/ See references 12, 15, 30-32.

13/ See reference 36.

although the Director General had informed the Board in 1972 that these were satisfactorily determined. The lag in completion of subsidiary arrangements with Euratom and their associated facility attachments has meant in practice that it is impossible for the IAEA to adequately verify the status of nuclear materials and facilities because it lacks the inspection procedures spelled out in those documents. As long as these are not completed, application of IAEA safeguards in Euratom will remain res dubia, which is to say that these safeguards would not be those legally required. Only after I put this warning into writing was partial information about this dubious situation given to the Board of Governors. Without completion of the subsidiary arrangements for Euratom, the IAEA had the right to refuse to apply safeguards. Such a refusal would have given strong impetus to complete negotiations since NPT States may not have any unsafeguarded activity. I consider this situation to be virtually a violation of the IAEA statute 14/ which requires timely involvement of the Board and a decision based on fair knowledge of the facts.

Superiority of Euratom safeguards.--Euratom safeguards, it should be noted, are less limited in inspection rights and in implementation than are those of the IAEA. In general, Euratom safeguards are superior. Euratom inspectors have access to all places and persons. Their verifications are not limited by commercial sensitivity. Euratom by virtue of its long experience with a polynational safeguards system has accumulated valuable working experience with verification tools and mechanisms. Euratom has more authority than does the IAEA to resolve safeguards problems. Its responses are stronger, immediate, and include possibilities of sanctions. Unfortunately, the Director General in 1969 did not approve a proposal to correct the Agency's lack of ability in Euratom. 15/

14/ See references 36, 40.

15/ See reference 21, 39.

For adequate verification, the IAEA should be able to impose safeguards of a higher level of creditability, which it cannot do. The IAEA has to try to verify that no diversion has taken place in Euratom without having full access to all places and dates, and is constrained by restrictions upon its inspections which are "justified" by a need to minimize intrusion into Euratom safeguards. Additionally both the Euratom and Japanese safeguards agreements divide the inspection effort so that Euratom or Japan and the Agency each take a part. This means the Agency makes a smaller inspection effort in Euratom and in Japan than it would for comparable facilities in other states. Shared inspection, however, does not assure credible safeguards. It would not work reliably even with the fullest and closest cooperation of the safeguarded State. Independent, complete IAEA safeguards are the sine qua non for adequate verification.

Since the Euratom safeguards system appears to be superior, a pragmatic consideration indicates that the application of IAEA safeguards in Euratom is unnecessary and makes little technological sense. If IAEA safeguards could be applied satisfactorily and effectively, they would be a complete duplication of Euratom safeguards and therefore would be redundant.

Why dual safeguarding in Euratom?--Why then are IAEA safeguards superimposed on those of Euratom? They are applied mainly to satisfy the Soviet Union. Because of a political bargain, IAEA verification of Euratom is a "must". After this bargain was made, those of us in the Agency's safeguards operations thought IAEA safeguards should not be applied theatrically in Euratom but should be applied as in any other State, and that there should be no discrimination. Despite an enormous effort by safeguards operations, Euratom inspections were not going well when I left the Agency, and this politically complicated and confusing arrangement occupied nearly half of the active inspectors. This situation should be looked into because the ineffective application of IAEA safeguards in Euratom not only wastes inspection effort but also can discredit the reliability and effectiveness of IAEA safeguards.

At the 1973 IAEA General Conference, the Director General asserted that "we [the IAEA] can go to that conference with confidence in our performance under the Treaty." 16/ At the same time he further declared that the safeguards systems of Euratom and the Agency were coordinated in such a way ". . . as to permit the Agency to draw the same technical conclusions from safeguards work as in other states." This statement was made in spite of contrary views expressed to him by me as Director of Safeguards Operations and by practically all of the inspectors. It was incorrect then and remains so today.

Safeguards for Japan.--As for Japan, which was granted Euratom type safeguards by the Agency, its safeguards agreement should be brought as close as possible, preferably be made identical to, the standard safeguards agreement for all other NPT states. The alternative to remove this discrimination would be to give all other states the same kind of safeguards agreement. While this alternative might have some attractions, technologically it would be unreasonable with obvious political consequencies.

Diminution of inspection rights in negotiations.

In its negotiation of facility attachments, the IAEA has limited the Actual Routine Inspection Effort (ARIE) for each facility to a fraction of that legally permissable under the basic safeguards agreement. Such limitations are undesirable. Safeguards experience has proven the fundamental concept

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16/ See reference 48.

that the IAEA while avoiding intrusion should have the flexability to adopt its inspection effort to the situation at individual facilities. How containment, surveillance and accountancy are applied at a particular facility and how a State's national accounting and control system functions, all affect the level of inspection effort needed to ensure timely warning of the illicit activity. The IAEA should be able to determine the level dynamically in the course of safeguards operations.

The unfortunate idea of limiting the permitted inspection effort through secondary restrictions in facility attachments orginated during Agency negotiations with Sweden. The Director General subsequently decided to extend this "novelty" to all other member states some without consulting the Board and against the advice of safeguards operations. 17/ This example shows how the IAEA can make strange mistakes.

Containment and surveillance.

The application of containment and surveillance measures should not depend on a State's good will. It should be required in all safeguards agreements, both for NPT and non-NPT states. It is inaccurate to claim that such measures were not instituted by the IAEA because necessary equipment was unavailable. Neither availability of equipment nor of funds have hindered IAEA safeguards. No notable failure of IAEA safeguards can be ascribed to lack of financial resources.

17/ See reference 53.

Needed improvements in safeguards.

IAEA is behind in many improvements that are indispensable for reliable verification. My experience shows need for the following:

(1) Use of diversion path analysis to develop safeguards for facilities whose design does not include built-in features to facilitate safeguards;

(2) Development of reliable, tamper-resistant, self-reporting containment and surveillance equipment;

(3) Development of reliable, non-intrusive methods and equipment for non-destructive measurement of fresh and spent fuel;

(4) Development of reliable fuel bundle counters;

(5) Development and use of reliable automatic data services to process data on nuclear material flows, and for inventory verifications, and;

(6) Establishment of more safeguards field offices. 18/

I repeatedly recommended these and other measures to the Director General, who initially approved many of them but later withdrew his approval in order to make room for "induction" of Soviet interests into safeguards. 19/

Acceptance of inspectors.

The designation of inspectors to safeguarded states is a troublesome matter complicated by political difficulties and their operational consequences. The main problem arises from the nationality of inspectors. As a rule, States will not accept inspectors who are citizens of States in which safeguards are not applied. Most troubles arise with designation of inspectors who are citizens of the Soviet Union or sometimes other Warsaw-bloc States. Contrary to the

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18/ It took from 1972 to 1980 for the Agency to establish its first experimental field office in Canada. These are urgently needed to make more effective use of inspectors, and more important, for ensuring the continuity of knowledge about nuclear material by continuous availability of inspectors in this way. See reference 19.

19/ See references 2, 3, 7-9, 13, 15, 18-25.

Director General's reports to IAEA General Conference and UN General Assembly, 20/ situations would be improved if IAEA were to recruit and designate inspectors who could be used for field work, that is to say, who would be acceptable to the inspected states, instead of publicly putting the pressure on non-nuclear weapons states to accept any and all inspectors. 21/ The IAEA should concentrate on convincing nuclear-weapon states to open their non-military nuclear installations to IAEA inspectors and verification, as a step polically necessary to achieve broad acceptance of their inspectors.

Automatic Data Processing (ADP)

The Automatic Data Processing system for IAEA safeguards probably is unique both in its importance for effective performance of safeguards and in its political complexity. However, from the beginning of attempts to process data systematically in 1968, development of safeguards ADP has been delayed year after year. Much of the data had to be manually recorded, thus limiting its usefulness. In 1975, against the advice of safeguards staff, a task-force was formed, headed by a Soviet national whose field was not safeguards. The task-force failed. The designation of another Soviet national in 1976, again whose field was not data processing, to head a new Safeguards Information Division was made against the advice of experts and without due regard to the Statute. 22/

As late as the end of 1980, the ADP system still was only partially operational. Not all safeguards data could be processed and the systems' readiness for practical use had not been confirmed. One indication of the problem is the incompleteness of the 1980 Safeguards Implementation Report in respect to

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20/ See references 33, 34.

21/ See references 10, 27-29.

22/ See reference 30, Article VII.

safeguards data processing. Fortunately, the ADP system now is operational, but is still not much use for inspectors. Until recently, there were hardly any inspection reports in the system's memory. The IAEA's basic materials accounting concept, that is to say, material balance areas, works poorly in practice. Data processing still lags behind so that inspectors do not have ADP as a strong tool, which is absolutely necessary for effective inspection of fuel cycles facilities through which nuclear material of large strategic value flows and undergoes substantial changes of composition, structure and quantity.

Improper access to confidential safeguards data.

Since some of safeguards data is confidential, I introduced modifications 23/ in procedures to protect confidential data from unauthorized access. Security of confidential safeguards information is important to Member States to protect their industrial and commercial nuclear interests. So the decision of the Director General to permit access to safeguards data by a national of a country which does not have and does not intend to have its facilities under IAEA safeguards was politically questionable. In essence, this decision enabled nationals of one country to get access to confidential safeguards data about another state without the prior consent of the State involved. I raised this matter with the Director General several times and finally wrote to him that:

> "it is not politically wise that citizens of nuclear weapons states, especially those who do not expose their facilities to international safeguards, have under their control all confidential safeguards

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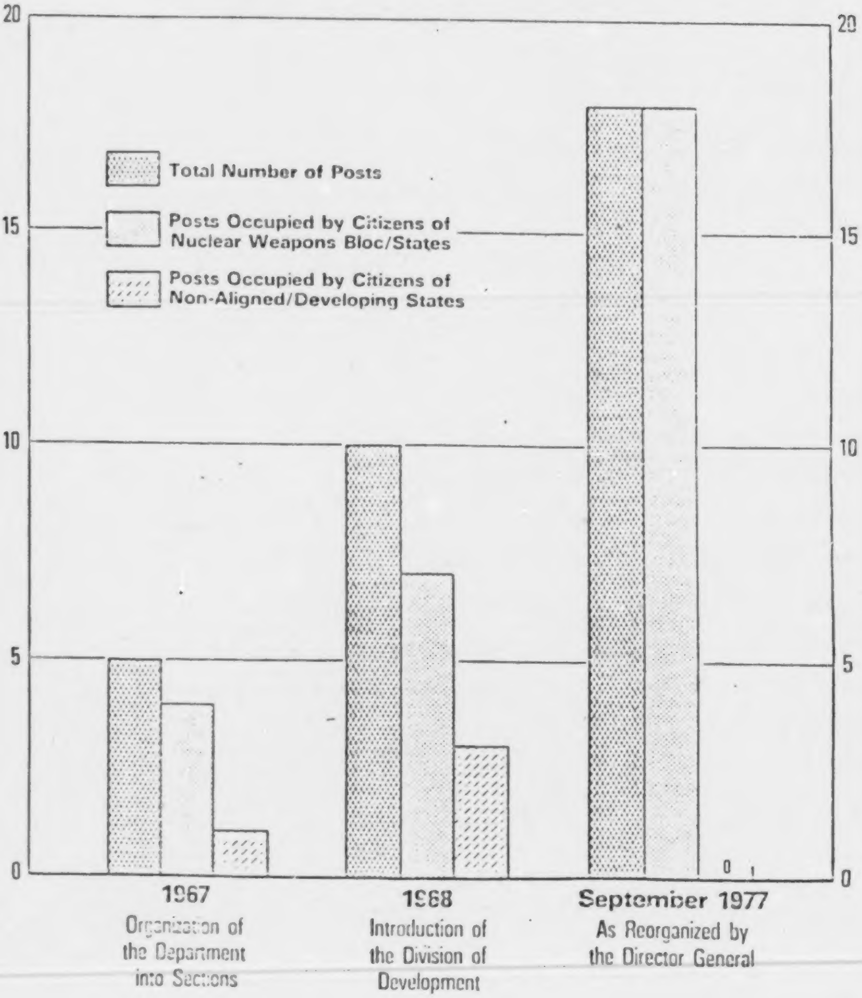
23/ See reference 42. On November 15, 1973, as Acting Inspector General, I issued the instructions "Security of Confidential Papers," when the Federal Republic of Germany had informed me that the Bundestag in Bonn during its deliberation on ratification of NPT Safeguards Agreement had questioned the adequacy of protection of industrial and commercial data at IAEA.

Figure I

Distribution of Section Head and Division Director Posts in the IAEA Department of Safeguards



> data (design information for facilities, all States' and inspection reports, etc.). My experience strongly indicates that Agency posts which involve access to confidential safeguards information should be filled by experts from non-nuclear weapons states." 24/

Finally, accessability to safeguards data via computer terminals, and decoding possibilities are matters in need of attention.

Big power influence of IAEA staffing.

Over recent years nationals of the nuclear weapons and large nuclear power states have filled an increasing proportion of the supervisory posts in the Department of Safeguards, so much so that by 1977 all of the key posts were occupied by citizens of nuclear weapons states and their bloc countries. For many years, the development, operation and administration of safeguards were in the hands of a citizen of a non-aligned state, 25/ as a result of a political compromise reached in the 1960s. But super powers political trading changed the situation. Figure I shows this unfortunate and undesirable unbalance which arose in 1977 and remains to date. The recommendations of the 1974 group of experts to advise the Director General on the structure of the department of safeguards were ignored and kept "confidential" 26/. In 1977 the Director General replaced all members of this group of experts except for those from the Soviet Union and the chairman, who was his close friend. The new structure was used to accomplish a peculiar redistribution of supervisory posts in safeguards. Here are some examples of undesirable changes in Agency staffing.

24/ See reference 9.

25/ The author.

26/ See reference 43. See also pages 2-38 and 2-39.

The Director of Safeguards Development, a citizen of Spain, was replaced by a citizen of the Federal Republic of Germany. The Director of Safeguards Operations, a citizen 27/ of a non-aligned State--Yugoslavia--was replaced by two new directors from bloc states: one from Japan and the other from Czechoslovakia. Splitting safeguards operations into two Divisions was contrary to the advice of the Group of Experts in 1974, 28/ which strongly recommended that operations be kept in one division to avoid politically undesirable discrimination in implementing safeguards.

As mentioned earlier, another important and critical post, the Director for Automatic Data Processing, was created especially for a Soviet national. Consequently, four director's posts are now split between the Eastern and Western blocs. Not one is held by the third world, which represents hundreds of states.

Because of Soviet threats in 1976-77 to withdraw from the IAEA, the United States agreed to this one-sided personnel distribution in favor of the Soviet Union, and to appointment of Czech and Soviet nationals to these two, newly created, director's posts 29/ which has had an adverse effect on the impartiality and objectivity of IAEA safeguards.

27/ The author.

28/ See reference 43. See also page 2-39.

29/ The identity of the Soviet citizen who will automatically replace the present Soviet director in second half of this year was known some months before the Board of Governors gave the "greenlight for his appointment." The Director General's custom to rotate the citizens of super powers or the individuals on whom the super powers rely in respect of key posts makes the Agency's advertising for candidates a theatrical matter. Applications by candidates from non-nuclear weapons states, are, to put it kindly, illusory. Also, incumbents of Key Agency posts are often reappointed by the Director General, and as a rule, at higher, sometimes much higher rank which is contrary to the practice for citizens of the non-nuclear weapons states.

It is not pleasant to look back at some of these politically negative events which could have been avoided by an objective leadership immune to influence.

Relation of inspectors to Agency management.

Safeguards depend upon how well inspectors perform their duties which is influenced by their relations with their supervisors, other personnel of safeguards operation and the staff of the IAEA. As the Group of Experts advised the Director General in their 1974 report: 30/

> It must be emphasized that changes in organizational structure will, as such, not result in improvements in operational efficiency unless there is cooperation, trust, confidence, and respect between the international civil servants functioning in an international organization. This is a sine qua non for the effective working of the Department as it is for any other Department of the Agency.

The Director General did not distribute this report until the Governor from the Federal Republic of Germany asked for it at a Board meeting. It was finally distributed on June 13, 1975, with the lame explanation that it had been "under careful study" in the Secretariat. Thereafter the Director General ignored the recommendation. His new group of experts repeated this recommendation in its report of 1977 and added that it was ". . . crucial for the effective functioning of the Department [of safeguards], and that significant improvements must be made" since "it is obvious that not enough attention has been paid to this matter . . ." 31/

The lack of comprehension for political, technological and above all human complexity in handling urgent safeguards key tasks, is clearly troublesome, so much so that the delicate and complicated duties and hard life of the inspectors,

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30/ See reference 43, par. 20.

31/ See reference 44, p. 4.

who are the Agency's real safeguards capital, have never been properly understood and respected. 32/

Need for a strong response to diversion or non-compliance.

It is the political obligation of a State in which IAEA safeguards are applied to do what is necessary during IAEA inspections to show that it has not violated its nonproliferation undertakings. If safeguards are to deter misuse of nuclear power, safeguarded States must know that strong, effective political action will promptly follow any detection of diversion or instance of noncompliance with a safeguards agreement. Failure of a State to supply required data or access of inspectors cannot be condoned. Such refusal should trigger an immediate political response because it could be a first step in a protracted diversion scheme, or an attempt to test the Agency's resolve.

This truth, which should be self evident, is seen differently within the Agency. During my term as head of safeguards operations, many inspectors argued strongly that Agency inaction in the face of noncompliance with a safeguards

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32/ For example, the career possibilities for the inspectors are anything but promising. Promotion depends more on the pressure of the influential states than on performance. No active inspector has ever been promoted to the Director's level. Five year contracts, crucial because of continuity and career reasons, were introduced for inspectors only after long struggles of safeguards operations with the Agency's bureaucracy. How much safeguards were damaged by these irregularities and frictions and how much the inspectors suffered is well known. The organizational conditions must be improved for the proper functioning of the inspectorate. Here is one example of an incredible case: An I.L.O. tribunal's judgement, No. 431, in the case of IAEA inspector Mr. Teodor Rosescu, held that IAEA Director General had misused his authority and violated the Statute (Article VII-F), when, against the interest of the IAEA and of this experienced and didicated safeguards inspector, he interrupted the inspector's contract upon request of the Government of his State. (c.f. references 54, 57). It is more than clear that promising career possibilities and fair treatment of inspectors are crucial for future of safeguards.

agreement constituted an unhealthy de facto acceptance of such behavior. The bureaucracy, however, was more permissive. As I look at the Agency, I see a great difference between on one hand the ability of its inspectors to detect and report noncompliance with safeguards agreements, and, on the other, the will and ability of the bureaucracy to undertake an adequate political response.

Insufficient information for the Board of Governors.

A reasonable reading of the IAEA Statute is that the Director General is to keep the Board of Governors fully and currently informed. Article XII stipulates that "the inspectors shall report any non-compliance to the Director General who shall thereupon transmit the report to the Board of Governors." [Emphasis added] Yet, in one instance when inspectors found and reported an unauthorized removal of a fuel element, this was not reported to the Board of Governors. In the author's experience, it would be better to err by submitting too much information to the Board than too little.

Of greater importance, for years the Board was not informed about the extraordinary importance of safeguards concepts, approaches, methods and techniques, and other matters affecting the safeguardability of facilities containing materials of high strategic value. The vulnerability to diversion of reprocessing facilities, fast breeders and CANDU type reactors was not explained. The Board was not made aware of arbitrariness in defining and relating various parameters used in verification; or that the uncertainty of measurements, limitation of containment, and softness of surveillance; the weakness of materials accountancy and doubts about verification of nuclear materials flow, all of which meant that nuclear material in such facilities might not be properly controlled. As Director of Safeguards Operations, I also brought up these matters during my visit to various U.S. agencies in Washington and with some Congressional staff in January 1976.

Inadequacies of the Safeguards Implementation Reports (SIR)

Under pressure from many sides, the Director General in 1977 began to make annual Safeguards Implementation Reports to the Board. However, the SIRs did not fully inform the Board and tended to cover up failures of the Secretariat. 33/

My reading of the SIRs shows that they tend to focus the attention of the Board on less significant or trivial matters, such as the number of incomplete Facility Attachments instead of explaining reasons for the delays; on budget problems, which never have been a safeguards problem; and on the continuing refusal of some States to accept inspectors of certain nationalities, without mentioning the reluctance of many states, including the United States, to accept inspectors from countries that are not to IAEA safeguards.

SIRs and the Director General's report to the United Nations.--The Director General's annual reports to the United Nations have included overly optimistic statements about accounting for nuclear materials. For example, in 1979 he informed the United Nations General Assembly that: 34/

> "The Board of Governors considered that it is reasonable to conclude that all nuclear material under Agency Safeguards in 1978 remained in peaceful activities or was otherwise adequately accounted for. Essentially the same conclusion was reached in previous years."

However, it should be noted that the SIR for 1976 reported there was no diversion at all. 35/ As Director for Safeguards Operations, I had opposed so sweeping a conclusion because it could not be based on the inspectors' reports but rather rested upon an arbitrary "element of judgement" by the Secretariat. 36/

33/ See references 12, 15, 31, 32.

34/ See reference 34.

35/ See reference 12.

36/ See reference 15.

My reason was that only at some facilities was there continuity of knowledge for materials of strategic value. My comment was ignored. The SIR for 1977 reported that: 37/

> ". . . all safeguarded nuclear material remained in peaceful activity or was otherwise adequately accounted for, taking into account all circumstances including qualitative observations." (emphasis added)

Subsequent SIRs limited this statement to States where safeguards agreements were in full implementation. In doing so these SIRs ignored the Agency's responsibility to safeguard materials from the time of entry into force of a Safeguards Agreement and did not inform the Board that materials accounting information was incomplete because materials balances could not be closed at a number of facilities as is legally required. 38/

The SIR for 1978, while stating the same conclusion as earlier ones, added yet the qualification that: 39/

> The Secretariat considers it reasonable to conclude . . . on the basis of additional information that nuclear material under the IAEA safeguards remained in peaceful nuclear activities. (emphasis added)

This additional conclusion is contradictory to fundamental concepts of safeguards and provisions of the Agency's basic document on safeguards in which quantified verification based on the closing of materials balances is required. My professional experience and my long association with IAEA safeguards make it clear that "reasonable conclusions" based on unspecified "additional information" and "qualitative observations" are so vague that they cannot replace quantified verification. Yet in 1979, the Director General informed the U.N.

37/ See reference 31.

38/ See reference 10.

39/ See reference 32.

General Assembly that although safeguards were not without some difficulties, these difficulties, had not resulted in any impairment to IAEA safeguards activities, and concluded that " . . . it seems to have become a truism that where the NPT and IAEA safeguards end, the danger of proliferation begins." 40/ This euphoria was not supported by the views of competent analysts who are known as strong supporters of safeguards. 41/ Nothing could be more misleading than introduction of arbitrariness and vagueness.

Misuse of inspectors to collect intelligence.

During my term as Director of Operations, inspectors were instructed in 1970, over my objection, to collect information about facilities which were not, and were not expected to be, under safeguards in non-nuclear weapons states. 42/ Despite my objections and those of my inspectors, this irregular instruction was not withdrawn until I informed the United States and Soviet representatives to the Agency that I would resign if this illegal instruction continued. It was then withdrawn.

A particular case of collecting informations in a country about unpublished nuclear programme and individual facilities not under safeguards occurred in 1973. Here again the Director of Operation was bypassed by this instruction. The Director General refused to stop this and/or to inform the Board. Again only after the U.S. and USSR representatives had been informed was the instruction withdrawn. The Board of Governors was never informed.

40/ See reference 34.

41/ See references 4-6.

42/ See reference 47.

These episodes illustrate the risks that can result from inadequate timely information to the Board of Governors. They could have caused a scandal of major dimensions.

Unwise discrimination in inspection.

Recently the thinking of the Secretariat would concentrate inspectors on those non-weapons states where, according to IAEA guesses, the temptation to divert might be high. A good example of this view is to be found in the remarks of the Agency's Deputy Director General for External Relations to the American Nuclear Society's Executive Conference in 1979. He said: 43/

> . . . we [the IAEA] sometimes pay too much attention to the technical perfection of safeguards and too little to the political considerations . . . as a result . . . safeguards are heavily concentrated in industrial countries where diversion is rather unlikely, but where there are large and sophisticated fuel cycle facilities that gobble up safeguards manpower . . .
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> . . . but politics might point in other directions--to the concentration of safeguards on relatively small R&D fuel cycle facilities in countries where the temptation to divert may be far higher. [emphasis added]

I question both the criteria and the wisdom for the IAEA to discriminate in this way between States which have concluded the same safeguards agreement with the IAEA. Without doubts, Japan and the Federal Republic of Germany are the two states that consume much safeguards manpower, although diversion there is thought to be unlikely. But is this because of their Western bloc orthodoxy, or because their governments are permanently magnanimous or deigratia? My reading of the Statute is that all States must be treated justly. All must be adequately safeguarded. Discrimination in level of safeguards preference has no place in the Agency.

43/ See reference 50.

Cooperation with China.

Another Agency mistake was not to keep People's Republic of China informed of the status of IAEA activities, the advantages and disadvantages to China of Agency membership, and of the steps on both sides that would be necessary should China wish to join. For some years, when I was Director of Safeguards, I made every effort to convince the Director General to keep China well informed so that it could base a decision about joining the IAEA upon accurate, relevant facts. However, the idea of cooperation with China was treated virtually as heresey, probably because of pressure from the Soviet Union. It would be "better late than never" for the Director General to personally keep China informed of IAEA activities.

Weaknesses in IAEA safeguards development.

The IAEA weakness in scheduling and planning long-term technological development for safeguards, its heavy reliance on short-term interests of the super powers, and its carelessness with operational problems are the main reasons why safeguards implementation problems have persisted. 44/

The Agency's safeguards development has been keyed to assist the expanded use of low-enriched, light water reactors, which are the prevailing types in the Soviet Union and the United States. Safeguards technology for the heavy water, natural uranium, CANDU type reactors is not as mature nor is it for other types of nuclear facilities not favored by the superpowers. Thus the IAEA has neglected some of the most critical parts of promising alternative fuel cycles. 45/

44/ See references 3, 7, 32.

45/ See reference 9.

Another weakness in IAEA safeguards development is the disproportionately large part of the development budget funded by the United States. Effective use of the $5 million appropriated by the Congress to strengthen and support IAEA safeguards requires a realistic assessment of the most urgent needs. The IAEA was not able to use all of the U.S. aid reasonably. Too much emphasis has been on outside consultants, who, while trying during last years to improve safeguards at full gallop, often are up in the air. In addition, technical matters are mixed with political and human ones. Hundreds of papers circulating at endless meetings, where productivity is inversely proportional to the quantity of papers and the number of participants, have resulted in progress at a snail's pace.

One result of the United States carrying a large share of the development budget is that the Soviet Union benefits greatly, without making a comparable contribution. Moreover, other nuclear power states have less interest in financially supporting safeguards and the rest of IAEA Members have little if any interest in carrying any important part of this burden. As a result, control of safeguards development falls primarily into the hands of the superpowers.

This situation will continue as long as the IAEA leadership does not strive to broaden support for safeguards development among more Member States. The IAEA has not arranged its safeguards development so as to make participation attractive to the non-nuclear weapons States. Besides, some of these States have come to consider safeguards a peculiar and exclusive problem of the nuclear weapons States. As a result, the abyss between the weapons States and non-weapons States has widened.

Finally, safeguards development is basically a scientific and technical matter, not a religious one. The IAEA's leadership should be able to face and to use new facts, discoveries and more efficient concepts and approaches, and, with this in mind, *mutatis mutandis*, to treat the existing numerous critical analyses and judgements and/or to do comprehensive assessment of the impact of current limitations. However, courage and wisdom is needed for this.

The IAEA's restrictive and discriminatory approach to safeguards

The IAEA's restrictive and discriminatory approach to safeguards can also cause dangerous resistance to safeguards, even by States that do not intend to make nuclear weapons, and the process may be irreversible. If this continues, the nebulous containment offered by safeguards may become uncertain, just as is the "Solemn declaration by the Governments of the states not to produce nuclear weapons," which was discarded as insufficient long time ago. International verification of pledges is tremendously important for what it leaves out. That is why I have endeavored, using my experience, to focus attention on safeguards limitations since 1964. I hope this report will provide an impetus for further hard headed thinking about safeguards and their future.

Improvements of safeguards frequently must be accomplished in a hostile political environment, influenced by the absolutism of the superpowers and their blocs as they disregard their obligation to help other countries with nuclear energy and as they continue increase their nuclear arms. It is no surprise that most IAEA Member States oppose strengthening and improving safeguards for the nuclear power that they do not have. It follows there should be an adequate program for nuclear power development and technology transfer that should go hand in hand with safeguards and other means to protect the world from further dangers of both the spread of nuclear weapons and the increase of existing nuclear arsenals.

In conclusion

International safeguards are neither a "cops and robbers" game nor an intelligence play within a play. Safeguards have to deal with the real world to which the Agency should give its full attention rather than waste precious time and energy in dissembling and saving face. Reality in the 1980s requires that truly international cooperation among all IAEA Member states replace bilateral attempts by a few at domination. So I hope that the United States and the Soviet Union will consult widely with all non-nuclear weapons Member States, whether they be developed or developing, bloc or non-aligued, on the delicate political matters yet to be resolved. The recent failure of the United States to impose its thinking upon the International Nuclear Fuel Cycle Evaluation is a graphic reminder that future rectification of the Agency's faults will come more from international cooperation and censensus than from unilateral or bilateral attempts at dictation. I hope this lesson will not have to be learned again in the IAEA Committee for International Plutonium Storage and in its Committee for Assurance of Supply. Without broad and long-lasting political consensus among Member States, the advancing spiral of nuclear technology can obsolete present concepts and measures to prevent the further spread of nuclear weapons.

Unfortunately, the prospects for a substantial break with past Agency policy to overcome stagnation and sometimes less than honest behavior do not look good without a strong will to straighten out its political problems. Based on my almost 24 years of experience with the Agency, first as a delegate and later as director of safeguards operations, I am forced reluctantly to conclude there is one thing really wrong with the IAEA. It stinks of politics, so much so that many non-nuclear weapons states participate in its programs halfheartedly and with suspicion. Fortunately, I see signs that the dominance of the superpowers is beginning to fade.

Just because political problems trouble the Agency, is no reason to stand idly by and do nothing to improve safeguards. Safeguards are worth every effort to perfect and to protect. They are truly a unique international undertaking in human history. They already have had and will continue to have vitally important effects for the future of humanity. So decisions affecting the credibility of safeguards must rest firmly on a long-term and consistent strategy. Likewise, the faults of safeguards must be faced and rectified today lest preventable abuse of nuclear power preempt the future use of uranium for the benefit of mankind. Since verification by inspection is the very heart of safegurds, a major matter for the 1980s will be the adequacy of and limitations upon inspection efforts. It bears reiteration that the most urgent matter is the careful identification of weaknesses of the IAEA and its safeguards, and the taking of prompt corrective action. Improvements that my experience shows are needed include the following:

1) Standardization of inspection requirements so that inspection effort cannot fall below a minimum consistent with effective safeguards implementation;

2) Design of nuclear facilities to facilitate application of safeguards and to minimize risks of diversion;

3) Continued development of safeguards technology and systems in step with new advance in nuclear power technology so that diversions from changed or new nuclear fuel cycles can be deterred by effective inspection;

4) Greatly increased political costs and consequences for nuclear diversions and of non-compliance with safeguards agreements;

5) Maintenance of trustworthy relations between the Agency and all of its member states. The Agency should not vascillate between friendship and hostility in its attitudes towards any of them;

6) New leadership by able and politically skilled men to revitalize the Agency's Secretariat and to take imaginative steps to solve the crucial problems facing the Agency; 46/ and, lastly

7) Reconsideration by the United States of its fundamental assumption that it and the Soviet Union together can decide the future course and pace of the spread of nuclear weapons.

In conclusion, if IAEA safeguards and IAEA management are weak, the value of the non-proliferation commitments of the Nuclear Non-Proliferation Treaty will be correspondingly weakened. Things could get out of control and the worst could happen. It is not correct to say, as the present Director General has said, that only where safeguards end do the dangers of proliferation begin. Safeguards are necessary, but alone even perfect safeguards would be insufficient. To promote the illusion that safeguards by themselves can make the world safe from misuse of nuclear power is a grave disservice for public understanding of how proliferation can be prevented. I hope that the reader can now come to his own conclusion about these *petitio principii*. To do so will not be easy for the situation is complicated. The facts are far from clear and do not conveniently point to what has to be done and how to accomplish it. So it is time for an urgent, comprehensive, and critical reexamination of safeguards. Let us get on with it. *Tempus fugit!*

46/ This suggestion was made by Mr. Usmani, the former chairman of Pakistan's Atomic Energy Commission, as long ago as the General Conference of 1969! See also reference 26.

REFERENCES

1. Nakicenovic, S. (1967), Notes on Safeguards -- Personal thoughts, Third Review, March 20, 1967, IAEA, Vienna.

2. Nakicenovic, S. (1976), Contribution to Agency Safeguards, December 1976, IAEA Vienna.

3. Nakicenovic, S. (1977), A Few Final Lines, September 15, 1977, IAEA, Vienna.

4. Scheinman, L. (1977), International Safeguards: Objectives, Status and Unresolved Issues, A United States View, ANS, October 17, 1977.

5. Nye, J. (1977), International Conference on Nuclear Power and Its Fuel Cycle, Proceedings, IAEA, Vienna.

6. Ikle, C. (1980), "Bombs and Reactors: The Nuclear Divide", The Bulletin of Atomic Scientists, January 1980.

7. Nakicenovic, S. (1976), Safeguards Effectiveness, May 7, 1976, IAEA, Vienna.

8. Nakicenovic, S. (1977), Measures Adversly Affecting our Work and How to Strengthen Safeguards, February 1977, IAEA, Vienna.

9. Nakicenovic, S. (1977), Safeguards at the Crossroad (written for the IAEA Governors), June 19, 1977, IAEA, Vienna.

10. IAEA (1972), The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153, IAEA, Vienna.

11. IAEA (1979) and (1980), General Conference, Records, December 1979 and December 1980, IAEA, Vienna.

12. IAEA (1977), Special Safeguards Implementation Report, GOV/1842, IAEA, Vienna.

13. Nakicenovic, S. (1977) Where We are Now, IAEA, Vienna.

14. Nakicenovic, S. (1975), Experience in the Application of Agency Inspection Practices SM-201/105, IAEA, Vienna.

15. Nakicenovic, S. (1977), Comments on the Director General Remarks Introducing Discussion of Safeguards Items, IAEA, Vienna.

16. Nakicenovic, S. (1976), Preparation for Safeguarding in Euratom and Japan, IAEA, Vienna.

17. Nakicenovic, S. (1966), Some Notes on Safeguards, February 2, 1966, IAEA, Vienna.

18. Nakicenovic, S. (1974), Working Paper on an Alternative for Organization of the Department of Safeguards and Inspection, January 28, 1974, IAEA, Vienna.

19. Nakicenovic, S. (1970, 1972, and 1976), Field Office, IAEA, Vienna.

20. Nakicenovic, S. (1976), Some Notes on the Organization and Administration of Agency Safeguards, IAEA, Vienna.

21. Nakicenovic, S. (1969), Euratom Preparation: Information for the Director General, EUR/MEMO 3, IAEA, Vienna.

22. Nakicenovic, S. (1975), The Most Urgent Safeguards Key Tasks, IAEA, Vienna.

23. Nakicenovic, S. (1976), Safeguards of Reprocessing Plants and Large Quantities of Easy Convertible Fissile Material, IAEA, Vienna.

24. Nakicenovic, S. (1976), My Proposals for Strengthening Safegaurds, IAEA, Vienna.

25. Nakicenovic, S. (1976), Effectiveness of Current Safeguards Operations, IAEA, Vienna.

26. Usmani, I. (1969), Developing Countries and IAEA, The Inter Services Press Limited, Karachi.

27. IAEA (1968), The Agency's Safeguards System, INFCIRC/66/Rev. 2, IAEA, Vienna, also provisionally extended versions, 1966 and 1968.

28. IAEA (1965), The Agency's Safeguards System, INFCIRC/66/Rev. 1, IAEA, Vienna.

29. IAEA (1966), The Agency's Safeguards System, INFCIRC/66/Rev. 1, IAEA, Vienna.

30. IAEA (1973), IAEA Statute, as amended in June 1, 1973, IAEA, Vienna.

31. IAEA (1978), Safeguards Implementation Report, GOV/1911, IAEA, Vienna.

32. IAEA (1979), Safeguards Implementation Report, GOV/1939, IAEA, Vienna.

33. Director General of the IAEA (1979), Statement at the IAEA General Conference, December 4, 1979, IAEA, Vienna.

34. Director General of the IAEA (1979), Statement at the United Nations General Assembly, November 2, 1979, UN, New York.

35. Grumm, H. (1979), "IAEA Safeguards -- Where Do We Stand Today?", Iaea Bulletin, Vol. 21, IAEA, Vienna, August 1979.

36. IAEA (1973), The Text of the Agreement between Belgium, Denmark, The Federal Republic of Germany, Ireland, Italy, Lxemburg, The Netherlands, The European Atomic Energy Community and the Agency in connection With the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/193, IAEA, Vienna.

37. IAEA (1975), The Agreement between Japan and the Agency required in connection With the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC, IAEA, Vienna.

38. IAEA (1979), Implementation of Safeguards Agreements between the Agency and the European Atomic Energy Community and its Non-Nuclear-Weapons States, Report by the Director General, GOV/1923 and GOV/1934, IAEA, Vienna.

39. Schleicher, H. and B. Sharpe (1977), The Euratom Safeguards System as a Regional Control System, IAEA-CN-36/434, IAEA, Vienna.

40. IAEA (1968), Treaty on the Non-Proliferation of Nuclear Weapons, July 1, 1968, INFCIRC/164, IAEA, Vienna.

41. Nakicenovic, S. (1972), Operations Six-Year Programme, January 22, 1972, IAEA, Vienna.

42. IAEA (1973), Security of Confidential Papers, November 15, 1973, IAEA, Vienna.

43. IAEA (1975), Group of Experts to Advise on the Structure of the Department of Safeguards and Inspection, June 13, 1975, GOV/INF 297, IAEA, Vienna.

44. IAEA (1977), Group of Experts to Advise on the Organization of the Work in the Department of Safeguards and Inspection, May 17, 1977, GOV/INF 322, IAEA, Vienna.

45. IAEA (1979), The Secretariat of the Agency, May 1979, INFCIRC/22/Rev. 18, IAEA, Vienna.

46. An open letter to the Director General (not signed), March 8, 1976.

47. IAEA (1970), Facility Status Reprot, IAEA, Vienna.

48. Director General of the IAEA (1973), Statement at the IAEA General Conference, September 18, 1973, IAEA, Vienna.

49. Director General of the IAEA (1978), Report to the Board, December 4, 1978, GOV/1923, IAEA, Vienna.

50. Fisher, D. (1979), Role of Existing International Arrangements and Institutions, including IAEA, Nuclear Non-Proliferation Treaty and Regional Arrangements, ANS, September 11, 1979.

51. IAEA (1980), The Conclusions of International Fuel Cycle Evaluation, February 25, 1980, INFCE, IAEA, Vienna.

52. U.S. Congress (1978), the Nuclear Non-Proliferation Act.

53. Nakicenovic, S. (1971), Actual Inspection Effort, August 6, 1971, IAEA, Vienna.

54. ILO Tribunal (1980), Judgement Number 431 IN RE Roshescu, December 11, 1980, ILO, Geneve.

55. IAEA (1969), Report to the Director General by Consultants on Criteria for Safeguards Procedures, May 1969, May 1969, IAEA, Vienna.

56. Director General of the IAEA (1980), Statement at the Conference on the Review of NPT Operation, August, 1980, IAEA, Vienna.

57. IAEA (1978), Mr. T. Rosescu-Extension of Contract. November 16, 1978, IAEA, Vienna.

Peter Pringle

ON THE HILL

NUCLEAR UNSAFEGUARDS

NOT MANY would care to quarrel with Senator Charles Percy, the Republican chairman of the Senate Foreign Relations Committee, when he says that the spread of nuclear weapons is the "most important problem we face." Yet when his committee held public hearings on the subject last week, the response was dismal. Only 4 of the 17 senators on the committee turned up; the hearing was not reported at all in the *New York Times*, and the *Washington Post* carried a wire service version buried at the bottom of page 17.

Such apparent lack of concern is but one symptom of a disconcerting reluctance, especially on the part of the Republican-controlled Senate and the Reagan Administration, to take more than a weak-hearted interest in the problem. Only two Democratic Senators, John Glenn of Ohio and Alan Cranston of California, have been actively pursuing an oversight of the nonproliferation effort. A third, Gary Hart of Colorado, is semiactive, and Joe Biden of Delaware is supportive. That's about it. Percy himself reacts to their concern, and attempts to protect the Administration against quite justified charges that its nonproliferation rhetoric—"We are concerned and we are doing all we can"—is empty nonsense.

Indeed, the gap between the rhetoric and the reality is about as wide as it could be. Under Reagan, America's efforts to halt the spread of nuclear weapons have been steadily eroded. The Senate has voted to give aid to Pakistan by waiving a law prohibiting assistance to a country trying to make nuclear weapons (something Pakistan, most experts agree, is doing). The Administration has been unwilling to use diplomatic leverage against France for supplying nuclear fuel rods to South Africa (a country that refuses to accept international safeguards on its nuclear facilities); has agreed to supply Australia with classified uranium enrichment technology; has allowed Japan to reprocess (extract plutonium from) U.S.-supplied nuclear fuel; and, it seems, may soon permit India to do the same, despite India's refusal to accept full safeguards.

In the face of this willy-nilly spread of nuclear materials around the world, Percy's committee took a long overdue step in deciding to hold the first-ever hearings on the centerpiece of nonproliferation—the system of international safeguards imposed by nuclear supplier nations on states that want to have nuclear programs. In the event, the background to the hearings became as noteworthy as the hearings themselves. They had been prompted by an unusual stirring of dissent in the ranks of the nuclear establishment.

Last March a former International Atomic Energy Agency safeguards inspector, Emanuel Morgan, caused a flurry at the Nuclear Regulatory Commission with a report stating boldly that the Vienna-based IAEA is "incapable of detecting the diversion of a significant quantity" of nuclear fuel "in any state with a moderate to large nuclear energy establishment." In keeping with a well-established practice of institutional self-interest, the Morgan report was stamped "Classified," but word of its existence spread to Capitol Hill. In June the Israelis bombed the Iraqi reactor and in subsequent congressional hearings another IAEA inspector told of more failings of the safeguards system. In sum, these in-house voices declared the system unable to provide sufficient notice of a country's diversion of bomb-grade material to give other IAEA member nations a chance to use diplomatic leverage to stop the production of an actual weapon.

To the experts these "revelations" were nothing new. The nuclear establishment had known about the shortcomings of safeguards for years; it had just not been in their interest to tell anyone. Neither the nuclear industry (which sought the spreading of nuclear power) nor the governments of the supplier nations (which wanted their countries to have a slice of this new, exciting, and promising export trade) were willing to admit that in selling nuclear plants to less developed nations they might actually be selling bombs. The cover was safeguards. But over the years the negotiators of the safeguards system never managed to tie the development and deployment of safeguards to the development and deployment of nuclear power. The negotiators thought they had only to ensure a "continuity of knowledge" about the workings of a nation's nuclear plants, and they were content to allow the key question—how many inspections would provide such knowledge—to be decided on an ad hoc basis.

As the number of power plants under safeguards grew, so did the problems of the IAEA inspectors. There were simply not enough inspectors to do the job. Bomb-grade material in the form of highly enriched uranium was being supplied in increasing quantities (by France to Iraq, for example) and the "plutonium economy" was just around the corner. The coming of the breeder reactor, the one that makes more plutonium than it uses, would mean hundreds of tons of bomb-grade plutonium on the commercial market. If some crazy dictator didn't make a bomb out of it, surely a terrorist would.

The nuclear community still managed to fool Congress into believing that somehow the safeguards system would work, but Congress had a history of being bewitched by the magic of the atom. In the wake of the propaganda triumph of Eisenhower's Atoms for Peace Program, Congress had agreed to rewrite the Atomic Energy Act of 1946, omitting a key paragraph, Section 10a(1). It said, ". . . until Congress declares by joint resolution that effective and enforceable international safeguards against the use of atomic energy for destructive purposes have been established, there shall be no exchange of information with other nations with respect to the use of atomic energy for industrial purposes. . . ." Nobody bothered to examine whether safeguards were effective.

We now know, from the persistent digging of Glenn, Cranston, and others that the IAEA's failings are even greater than some of the nuclear community insiders on the Hill believed. For example, when the IAEA negotiates a safeguards agreement with a particular country, it lists the type of surveillance equipment and the number of inspections required to ensure that no bomb-grade material is diverted during the reactor process. But in some cases the agency has negotiated these agreements knowing that the equipment will not do the job. Also, because of the increasing work load, some reactors, subject to safeguards, were not inspected at all last year. As Senator Hart told the Percy committee, "The IAEA safeguards are little more than a facade."

FORMER INSPECTOR Emanuel Morgan told the committee bluntly, ". . . the fundamental objective of IAEA safeguards, to detect diversion of sensitive nuclear materials, cannot presently be met and will not be met in the foreseeable future. There is clear evidence of the fact that safeguards are not being met in the IAEA's *Safeguards Implementation Reports*, published annually for the years 1976-1980. These reports identify numerous gaps in the safeguards system, but inexplicably conclude that there has been no diversion of sensitive materials. It appears to me that most U.S. officials are not aware of the degree of inadequacy of IAEA safeguards." It was difficult for the nuclear community to dismiss Morgan as a disaffected employee: the NRC itself had endorsed his findings by announcing a few days before the hearing that it could no longer be "confident" that member nations of the IAEA "would be notified of a diversion in a timely fashion."

In the Administration's behalf, Under Secretary of State Richard Kennedy sought to curb criticism of the IAEA by saying that it was "generally" doing a good job, and that the job could be improved with more staff and a bigger budget. He omitted to tell the committee that the U.S. contribution to the agency has in fact been cut from $5.5 million to $4 million.

Two key witnesses, Victor Gilinsky, an NRC commissioner, and Paul Leventhal, a former Senate staffer and veteran campaigner for a stronger nonproliferation effort, argued that the first step to a better safeguards system is for the IAEA to open up its books. Leventhal, now president of the Nuclear Club, a nonprofit group opposed to the further spread of nuclear weapons, said: "Only in laying bare the technical and political limits of IAEA safeguards is there any hope to steer commercial nuclear enterprise away from technological paths that are unsafeguardable and, therefore, too inherently dangerous to be pursued for peaceful purposes." He was referring to the commercial use of highly enriched uranium and plutonium. In response, Kennedy warned of the fragile nature of the IAEA safeguard inspections, which involve a unique compromise of sovereign rights by many nations, and no one would disagree with him. But now that IAEA insiders are prepared to come clean about the failings of the system, critics like Leventhal are arguing that to save it from self-destructing, these failings must be aired and corrected.

The question is whether the Percy committee can summon a greater sense of urgency and concern. At the recent hearings the committee never came close to asking the right questions. This was partly bad luck: Senator Glenn, who said he had a host of questions for Kennedy, never had a chance to ask them because he was called away to vote. With the lack of leadership in the White House it may yet take another nuclear explosion—from, say, Pakistan—before members of Congress will sit up and take notice.

PETER PRINGLE

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ISRAELI ATTACK ON IRAQI NUCLEAR FACILITIES

HEARINGS

BEFORE THE

SUBCOMMITTEES ON
INTERNATIONAL SECURITY AND
SCIENTIFIC AFFAIRS

ON

EUROPE AND THE MIDDLE EAST

AND ON

INTERNATIONAL ECONOMIC POLICY AND TRADE

OF THE

COMMITTEE ON FOREIGN AFFAIRS
HOUSE OF REPRESENTATIVES

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STATEMENT OF FRANK S. HOUCK, PH. D., ACTING CHIEF, NUCLEAR SAFEGUARDS AND TECHNOLOGY DIVISION, NONPROLIFERATION BUREAU, U.S. ARMS CONTROL AND DISARMAMENT AGENCY

1. Mr. Richter, in his testimony, makes two basic assertions: First, that Iraq has embarked on a nuclear weapons program; and second, that the safeguards system of the International Atomic Energy Agency (IAEA) would not detect that program.

2. In making his assertions that Iraq has embarked on a nuclear weapons program, Mr. Richter presents no specific facts to support his claim except to refer to the existence of facilities and nuclear materials in Iraq.

3. The Administration is separately providing answers to the question as to whether Iraq was engaged in a nuclear weapons program. From our perspective Mr. Richter's testimony sheds no additional specific light on this question.

4. Mr. Richter makes a number of comments concerning various aspects of the IAEA safeguards system as it relates to Iraq. His main points are examined in the following paragraphs.

(a) He states that as much as 24 kilograms of plutonium could be produced each year in the Osirak reactor through irradiation of uranium. There is agreement (although not on this particular number) that significant amounts of plutonium theoretically could be produced annually in this type of reactor if natural or depleted uranium were introduced into the core or as a blanket. An essential condition, which Mr. Richter's testimony does not mention, to achieving such a capability is an uninterrupted supply (sufficient for frequent refuelings) of highly enriched uranium fuel, fuel which Iraq can not now produce and for the foreseeable future will not be able to produce. In our view, France, as the supplier of this fuel, would not provide quantities of fuel beyond that actually needed for the Osirak research program, a program which was to have been conducted jointly by Iraq and France.

(b) Mr. Richter implies in his prepared testimony that the IAEA does not acknowledge that clandestine plutonium production is a problem to be dealt with at material test reactors of this type. This does not coincide with our understanding. The IAEA has in the past recognized this to be a potential risk for various types of reactors, including some large research reactors, and has developed and implemented certain inspection measures for dealing with this risk. In our view, the internal IAEA documents referred to by Mr. Richter indicate that the IAEA is addressing this risk for material test reactors.

(c) Mr. Richter describes in his testimony the nature of inspection activities that have been carried out to date at the Osirak reactor. While we are not in a position to comment on the details of his description, it is our understanding that the main features in his description, i.e., counting, identification, and measurement with portable assay equipment of the highly enriched uranium (HEU) fuel assemblies, are indeed correct. We share his view that these are adequate activities for the HEU fuel itself. We also share his view that these activities are not sufficient for dealing with the diversion possibility of clandestine plutonium production at an operating reactor of this type. Where we disagree with Mr. Richter's testimony is in his implications that the IAEA clearly would not have carried out the necessary additional inspection activities after the reactor had commenced operations. We understand that the IAEA has been proceeding first to define the magnitude and nature of the potential problems, which would have to be faced once the reactor went critical, and then to identify and assess alternative inspection procedures for dealing with these problems. The use of surveillance cameras, mentioned as a desirable procedure by Mr. Richter, is one of several procedures being considered by the IAEA. We understand that the IAEA is considering measures beyond camera surveillance in its safeguards approach to detecting plutonium production at these reactors. The internal IAEA documents referred to by Mr. Richter suggest IAEA resistance to taking the necessary steps. We have been advised by the IAEA that the IAEA was in fact at the time developing plans for the necessary additional inspection activities and for including them in the facility attachment for the facility.

(d) A general implication of Mr. Richter's testimony is that the entire scope of IAEA safeguards in Iraq would have been no different in the future than in the past and that what was done in the past was inadequate. From our perspective this testimony fails to recognize the essential facts that the amount of HEU present was less than a significant quantity, that the reactor had not been in operation, and that, therefore, there was no produced plutonium to reprocess. It is, of course, only conjecture on Mr. Richter's part that Iraq would not have put under IAEA safeguards the hot cells and fuel processing facilities at the time that nuclear material was to be introduced into these facilities. Had Iraq failed to do so, it would have been in violation of the NPT.

(e) The testimony also implies that the safeguards system is inherently deficient, i.e., the legal basis of the safeguards system needs to be changed. While further rights for the IAEA might be envisaged, their existing rights are extensive and constitute the basis for an effective system. Under NPT safeguards agreements, states have an obligation to report to the IAEA all nuclear material in all peaceful nuclear activities. Mr. Richter stresses that inspectors can not go everywhere they wish to look for unreported material. It has long been recognized that it is not reasonable for IAEA inspectors to roam across a country looking for unreported nuclear materials and undeclared facilities. Rather, the approach that has been taken, which we believe is the only feasible approach, is for the IAEA to conduct inspection activities sufficient for ensuring that all reported nuclear material is adequately accounted for and that all nuclear material introduced into certain facilities under safeguards, such as reactors, will be known to the IAEA independent of the reporting by the state. This is in fact what the IAEA was proceeding to do. We believe that safeguards have to be conducted on this basis, rather than on the basis of searching for suspected or conjectured activities.

In addition, we must reiterate that all NPT safeguards agreements give the IAEA the right and obligation to ensure that safeguards will be applied on all nuclear material in all peaceful nuclear activities in the states concerned. We believe the IAEA Secretariat would have a clear basis for bringing the issue to the IAEA Board of Governors if it had any grounds for believing that an NPT party was not fulfulling its obligations.

Unfortunately, we believe, the testimony includes incorrect implications of other inadequacies in the formal basis for safeguards, for example, that the inspection effort allowed by the safeguards agreement is only three inspections a year. This is not correct. The Iraq safeguards agreement, like all other NPT safeguards agreements, allows up to 50 man-days of inspections per year, including some unannounced inspections, for each of the two research reactors provided by France (Isis and Osirak). The IAEA has the right to conduct additional ad hoc inspections of receipts of HEU fuel from abroad and, if all of this is not sufficient, additional special inspections. In short, we believe that the rights of the IAEA are adequate. The facility attachment for each facility would include an estimate of the actual amount of inspection effort that the IAEA considered would be needed at the facility. This could be well below the above amount, but would be subject to adjustments if needed. It is certainly true that the IAEA has manpower limitations which have reduced implemented inspection levels below that desirable. The IAEA is working to remedy this and we are supporting them in this effort.

(f) It is true that inspectors are individually accepted by inspected states. While there are certainly differences in the experience and training of individual inspectors, we generally believe that the IAEA inspectors are sufficiently motivated and geographically mixed that any collusion with inspected states is extremely unlikely. While this right of states to accept or not accept individual inspectors has been important in gaining acceptance of safeguards, there are also provisions in the safegards agreements to guard against excessive use of this right.

(g) In his description of IAEA inspections, Mr. Richter does usefully bring out one important point which has not received much focus. This is the difficult nature of the job of being an IAEA inspector. The inspectors, who are generally technical people and not diplomats, are in the forefront of a unique international experience in going into nuclear facilities in a country to verify that the country is telling the truth about its nuclear activities. The IAEA and its inspectors need the continued technical, financial, and political support of the United States and other like-minded countries. We hope that these hearings will help to reinforce and strengthen that support.

5. These comments have been shown to the IAEA, and the IAEA has advised us that our descriptions of the IAEA plans, procedures, and implementation measures are correct.

STATEMENT OF ROGER RICHTER, FORMER INSPECTOR, INTERNATIONAL ATOMIC ENERGY AGENCY

Mr. RICHTER. Thank you, Mr. Chairman.

It is both an honor and privilege for me to appear before the committee. It is my intention to present my views regarding the adequacy of the International Atomic Energy Agency safeguards system and how this system relates to the controversy surrounding the Iraqi nuclear program.

As the only American inspector in the section responsible for the safeguarding of nuclear facilities in Iraq, Israel, Pakistan, and India among other countries, I believe I have had a unique opportunity to gain an insight into the quality and effectiveness of the IAEA safeguards in a region of the world that is very much the focus of our government's efforts to contain proliferation.

The present heightened interest and concern on the part of the American people and the world community toward the effectiveness of the IAEA nuclear safeguards and nonproliferation efforts offers perhaps the best opportunity ever to identify deficiencies which exist in the system and to work toward resolving these deficiencies.

NEED TO STRENGTHEN IAEA

A principal objective of my testimony, Mr. Chairman, is to identify IAEA deficiencies and to strengthen what I believe to be the crucial mission of this most important international agency. The other principal objective is to explain why I believe that the Iraqi nuclear program was organized for the purpose of developing a capability to produce nuclear weapons over the next several years.

By way of discussing these two subjects and their relation to one another, I thought it could best be accomplished by explaining them from the perspective of an IAEA safeguards inspector who is charged with the responsibility of safeguarding the Osirak reactor.

WITNESS' BACKGROUND

But first by way of background, Mr. Chairman, I want to inform the committee of my relevant experience in the field of nuclear engineering. I hold a B.S. in metallurgical engineering and a master of science in nuclear engineering from the Polytechnical Institute of New York and the University of Maryland. The latter degree was attained under the auspices of the U.S. Atomic Energy Commission select intern program. I have been employed by the U.S. Atomic Energy Commission, the Energy Research Development Administration, and the Department of Energy from June 1968 until February 1978. During this time I was involved in nearly all aspects of the technology associated with nuclear fuel engineering, reactor irradiations and nuclear waste disposal.

While working for the Atomic Energy Commission, I have served as project engineer for the national program to develop advanced fuel for breeder reactors, as a site representative at the General Electric Breeder Reactor Headquarters in Sunnyvale, Calif., and the Westinghouse Nuclear Component Manufacturing Facility also in Sunnyvale.

I would also like to state that throughout my career I have been very pro-nuclear and continue to remain so.

On the basis of these relevant experiences, I was offered a position as a nuclear safeguards inspector with the IAEA in February 1978.

At the IAEA I initially served as an inspector in the Euratom section. I was a principal inspector at the nuclear fuel reprocessing facility in West Germany and at the fuel fabrication facilities in both West Germany and Italy. I subsequently replaced the lone American inspector in the south and southeast section when he returned to the United States.

I have been an active inspector in the south and southeast section for the past 2 years, until my resignation on June 26 of this year. In this capacity I have inspected small research reactors in Australia, Greece, Indonesia, Israel, the Philippines, Turkey, and Yugoslavia. I have had considerable inspection experience with the heavy water power reactors, the RAPPS 1 and 2 in Kota, India, and the General Electric supplied light water reactors in Tarpur, India, and at the nuclear fuel fabrication complex in Hyderabad, India.

I was recently involved in the final negotiations on behalf of the IAEA with the Government of India on the safeguard approach to the Prefre nuclear fuel reprocessing facility, located at the Tarapur site. I was to have been a key inspector in the implementation of the forthcoming inspections at the Prefre reprocessing plant later this year. I had in fact been offered, and I recently accepted, a 5-year extension of my present contract with the IAEA.

ROLE OF A NUCLEAR SAFEGUARDS INSPECTOR

Now, I ask the members of the committee to imagine for the moment that each of you is a nuclear safeguards inspector who will shortly be going to Iraq to conduct an inspection. To begin with, you have to imagine yourself as being a national of the Soviet Union or another Eastern bloc country, or possibly also a Frenchman.

Since 1976, all inspections performed in Iraq have been conducted by Soviet and Hungarian nationals. Recently, a French national was granted approval by Iraq to be an inspector, but he has not been to Iraq to make an inspection as of yet. This is a reflection of the fact that countries have the right to veto inspectors from whatever countries they choose; a right which they regularly exercise.

As an accepted inspector, you must keep in mind that any adverse conclusions you might reach as a result of your inspections would have to take into account your country's sensitivity to how this information might affect relations with Iraq.

THE INSPECTION PROCESS

In preparing for the inspection you must first give the Government of Iraq several weeks' notice of your planned inspection and obtain a visa. They may agree with the date or could, as has recently been the case, suggest you postpone or change your plans to a more suitable date.

Naturally, not wanting to create unnecessary friction, you will agree. You are now ready to go about the business of preparing yourself for the inspection. First, you should become familiar with the design information Iraq has provided to the IAEA.

You note that this design information is limited to describing the reactor, its operating characteristics such as power and flux, a description of the type and number of fuel elements, and of the irradiation ports. The hot cells provided by Italy for examination and processing of irradiated nuclear specimens for possible plutonium separation are not included in the information provided by Iraq. Nor is the radiochemistry laboratory, pilot reprocessing facility or the fuel fabrication line included in the design information available to the IAEA.

These facilities are not under safeguards and as long as Iraq maintains that it is not processing plutonium or fabricating uranium fuel in these facilities, they will remain outside of safeguards.

This may be disturbing to you as IAEA inspector. Nevertheless, you are aware that as a signatory of NPT only facilities which Iraq has declared to the IAEA as containing either thorium, natural or depleted uranium in metal or oxide form, or plutonium are subject to your examination. However, natural uranium in the form of U^{308}, which is commonly known as yellowcake, is not subject to safeguards, despite its potential for easy conversion to target specimens for plutonium production.

LIMITATION ON INSPECTIONS

You are not entitled even to look at the other facilities if Iraq has not adhered to its obligation under NPT, to report to the IAEA that material subject to safeguards is located in these facilities.

You are aware that the role of the inspector is limited to verifying only material declared by Iraq or France. You have no authority to look for undeclared material. Your job is to verify that the declared material accountancy balance is correct. The IAEA does not look for clandestine operations. The IAEA in effect conducts an accounting operation.

The amount and level of enrichment of the reactor fuel elements is indicated on your computer printout. But you notice that 100 tons of uranium in the form of U^{308} yellowcake is not on the list.

This is not an oversight but is a reflection of the fact that even though Portugal reported the shipment to the IAEA it is only a formality. The 200,000 pounds of U^{308} are not subject to safeguards. Had this uranium been in a slightly reduced form such as UO^2, it would have been under safeguards. But this loophole could enable Iraq to do as it pleases with the U^{308}. And so long as it does not report that the U^{308} has been converted into a material that is in the safeguarded category, you have no right to inquire of its whereabouts.

You are disturbed by this because you realize that in the other Italian-supplied fuel processing equipment which is not under safeguards, Iraq possesses the capability to convert in a rather simple fashion the U^{308} to UO^2 or even better, to uranium metal.

This could then be made into uranium targets which when bombarded by neutrons in the reactor core or blanket would be partially converted to plutonium. The targets could then be disassembled and reprocessed in the unsafeguarded hot cells and pilot reprocessing facility, and the plutonium recovered.

Since the U^{308} is not under safeguards, the material accountancy balance will not show that material has been withdrawn. The plutonium could therefore be accumulated without IAEA awareness. So long as Iraq does not live up to its obligation to admit to irradiating UO^2 or uranium metal in the reactor, you as an inspector have no recourse but to limit your inspection to the declared inventory.

As an inspector you have become aware that as much as 17 to 24 kilograms of plutonium could be produced each year with the Osirak reactor. Even if only one-third of this amount was produced in the first few years of operation of the reactor through the use of the attendant processing facilities, Iraq could acquire a stockpile of plutonium sufficient to make several atomic bombs.

This is because in spite of having signed the NPT, the most sensitive facilities in the nuclear reactor complex could remain outside of the purview of the IAEA as long as Iraq did not declare that they contained either plutonium or uranium metal, or oxide.

During these years when the plutonium stockpile is growing, Iraq could master the techniques of fabricating the plutonium configurations required for a nuclear weapon.

NUMBER OF YEARLY INSPECTIONS

Equally disturbing to you as an inspector is the realization that under the present negotiated agreement between the IAEA and Iraq, you will be limited to only three inspections per year, usually spaced at approximately 4-month intervals. Since the entire reactor can be emptied of the clandestine uranium target specimens within days, you as an inspector face the fact that by the time you arrive to verify the declared inventory of fuel elements which power the reactor, all evidence of illicit irradiations could be covered up.

NO TV OR PHOTOGRAPHIC SURVEILLANCE

Furthermore, under the present safeguard approach for material test reactors such as Osirak, no use of TV or photographic surveillance is made. Such surveillance could possibly provide an indication of accelerated withdrawal of specimens from the reactor prior to an inspection.

While it is recognized that such surveillance alone would not prevent clandestine plutonium production in the reactor, it could serve to reduce the ease by which the present laissez-faire approach to safeguarding large-scale material test reactors allows for optimized production of plutonium-239, which has a low plutonium-240 content. Such low plutonium-240 fuel is ideal for nuclear bomb construction, particularly for a country whose bomb-making capabilities are in the early stage of development.

In contrast to material test reactors in light water nuclear power reactors it is comparatively very difficult to divert any of the plutonium generated during operation, and the high fuel exposure times lead to a buildup of the undesirable plutonium-240 isotope. This significantly increases the level of sophistication necessary to produce a useful bomb from light water power reactors and also greatly increases the difficulty of reprocessing the fuel for plutonium recovery.

Moreover, unlike the light water nuclear power reactors where the IAEA TV and photographic surveillance have proven to be unsuccessful, MTR reactors do not readily lend themselves to unambiguous interpretation of surveillance results.

This is because in research reactors, the planned mode of operation is for frequent insertion and removal of experiments and radioisotopes. Consequently, the cameras would only reveal the frequency and time when experiments were inserted and removed from the reactor in between inspections. The amount of the material removed and the nature of the material, that is, are they isotopes for hospital use, or plutonium, could not be ascertained.

However, given the low level of materials research activity in Iraq, such surveillance could provide an indication of whether the amount of material withdrawn from the reactor is far in excess of any conceivable experimental research program.

INSPECTION OF OSIRAK NUCLEAR COMPLEX

Faced with these obstacles and constraints, you may now be wondering exactly what does an inspector actually do in the course of performing a safeguard inspection of the Osirak nuclear complex? So much of the potential safeguarding activities are beyond the scope of your inspection and the most sensitive facilities, in fact, are not even subject to safeguards.

Your inspection assignment is actually quite narrowly focused. First, you will sit down with the operator of the nuclear reactor and review your computer listing of the nuclear material which has been declared to the IAEA. This inventory should correspond to the declared inventory appearing in the facility's listing.

France as supplier of the enriched uranium fuel will have notified the IAEA of the type and amount of fuel delivered to the reactor. You will determine that the amount recorded by the operator is consistent with the amount reported to the IAEA by France.

If there is new, unirradiated fuel in the inventory, you will measure the fuel with a stabilized assay meter to determine that the elements indeed contain enriched uranium and have not been replaced by dummy replica fuel. This is particularly important in the case of the Osirak fuel since it would be a relatively easy matter to melt down the weapons grade highly enriched uranium fuel plates for use in a nuclear bomb.

IDENTIFICATION OF FUEL ELEMENTS

If the fuel elements are already in the reactor and have been irradiated, the inspection procedure normally requires that you visually identify the fuel elements. They can normally be observed under the approximately 20 feet of water. To confirm that these elements are not dummies, you have the right to ask the operator to turn on the reactor. When the reactor is operating, you should then see a characteristic blue glow known as Cerenkov Radiation emanating from the core. This is indicative of operating radioactive fuel elements.

Having done these checks, you have basically performed the most important elements of a nuclear safeguards inspection of a research reactor.

Thus far, this has been the easiest part of the inspection. The most difficult part lies ahead.

FINDINGS REPORTED TO IAEA

You will now return to Vienna and report that your inspection disclosed no discrepancies between the operator's records and that of the agency. You will report that you verified the unirradiated fuel with your stabilized assay meter and that you verified the irradiated fuel in the core by counting the elements and by virtue of seeing the reactor in operation.

The difficult part of the job is that you must prepare yourself mentally to ignore the many signs that may indicate the presence of clandestine activities going on in the facilities adjacent to the reactor, facilities which you were not permitted to inspect unless the host country has informed you that fuel elements from the reactor were transferred there.

You will now complete a standard report, filling in the blanks; you will try to forget that you have just been party to a very misleading process.

It is partially the result of such feeling that I was prompted a year ago to write a report of my concerns about Osirak to the Department of State U.S. mission to the IAEA.

IMPROVING IAEA

The U.S. mission representative indicated that he shared my concern and that he had forwarded my report to ACDA. He further indicated that the Arms Control and Disarmament Agency was well aware of most of what I had reported and that an effort was being made to improve the IAEA approach to safeguards in Iraq.

But as the most recent IAEA internal documents regarding these discussions show, there remains a very strong resistance to upgrading safeguards in the large-scale research reactors, which constitute the most dangerous threat to nuclear nonproliferation. The time is now at hand to act. No better time is likely to exist in the future for improving the IAEA safeguard system.

There is no other viable substitute for the IAEA. It is a very necessary agency with perhaps the most important job of all international agencies. It employs highly competent, motivated and sincere people, nearly all of whom share the same ideals and goals with respect to nuclear nonproliferation.

But the IAEA has been hampered by narrowly focused rights to conduct inspections bestowed by the member states. These rights need to be broadened and the IAEA must be enabled to conduct more comprehensive and better quality inspections. Each member state should ask itself whether its security and the collective security of the world community will be better served by improving the confidence and respect for the IAEA, or whether unbridled proliferation and short-term commercial advantages should take precedence.

Thank you.

THE ISRAELI AIR STRIKE

HEARINGS
BEFORE THE
COMMITTEE ON FOREIGN RELATIONS
UNITED STATES SENATE
NINETY-SEVENTH CONGRESS
FIRST SESSION
ON
THE ISRAELI AIR STRIKE
AND RELATED ISSUES

JUNE 18, 19, AND 25, 1981

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STATEMENT OF SENATOR ALAN CRANSTON

TWO BASIC QUESTIONS

I believe this hearing poses two basic questions. First, was the Iraqi Government, despite international safeguards, embarked upon a course which would yield nuclear weapons? And, therefore, can the Israeli raid on the Iraqi reactor fairly be deemed an act of self-defense?

Second, what steps can and should be taken to slow the spread of nuclear weapons? I warned in the Senate on March 17 that Iraq was embarked upon the systematic, determined effort to get the bomb. This conclusion was and still is shared by several key executive branch officials with whom I have been in contact.

IAEA DOCUMENTS

Additional information has come to me, Mr. Chairman, in the past several days which reinforces this conclusion. I have received four revealing internal documents from American sources within the International Atomic Energy Agency. These documents contain an estimate that Iraq could have produced enough plutonium each year in the Osirak reactor for up to three nuclear bombs.

Furthermore, these IAEA documents indicate that there is a significant possibility—indeed, probability—that this plutonium production would not have been detected by the IAEA inspectors.

Under the terms of Iraq's current agreement with the IAEA, inspections could be limited to three a year. Thus, Iraq could load its reactor between inspections but unload it before each preannounced inspection.

Under this procedure, Iraq could produce plutonium from unsafeguarded uranium yellowcake sufficient for one bomb every 4 months, without IAEA detection.

Two days ago IAEA Director General Eklund stated that such plutonium diversion in Iraq was not feasible and would be detected by the IAEA. This statement is contradicted by a special study conducted for the IAEA earlier this year which concluded that a reactor like Iraq's could produce as much as 24 kilograms of plutonium per year, as much as three bombs' worth.

In response to this study, an extraordinary meeting of nine senior IAEA technical specialists was convened to consider the dangers presented by the Iraqi program. Their unanimous conclusion was that such plutonium "diversion paths are technically practicable." They concluded that it was "very unlikely" that some IAEA member States like Iraq would accept the inspection activities necessary to detect such a diversion.

DOCUMENTS POINT UP FLAWS IN IAEA

These documents point up the fundamental flaw in the IAEA as presently configured. They show why there is presently no basis for public confidence in agency safeguards. The safeguards simply are not comprehensive enough to do the job, today.

The IAEA, unless we strengthen it, must negotiate with each host country what it will be shown and when it will see it. Inspectors simply come in after several weeks' advance notice, and they limit their check to predesignated facilities and material. This provides ample opportunity for any improper activities to be covered up.

I have also learned from an IAEA inspector in the section responsible for Iraq that several of the most sensitive Iraqi nuclear facilities were in fact under no international safeguards what ever. Not subject to inspection were the potentially sensitive hot cells supplied by Italy for fuel fabrication and plutonium reprocessing. Not subject to inspection was the stockpiled raw uranium yellowcake which could be used for plutonium production.

The documents I have obtained establish that the inspectors of the Iraqi program were not authorized to search for any clandestine bombmaking facilities.

ONLY SOVIET AND HUNGARIAN INSPECTORS VISITED IRAQ

I have also received information that since 1976 only Soviet and Hungarian inspectors have visited Iraq. Iraq had the right to object to any American citizen serving as an IAEA inspector. And Iraq had informally exercised that right.

The most recent inspection, in January, was reportedly conducted with the lights in the facility turned out. It was limited to a visual inspection of the fuel, and the whole operation was conducted by flashlight.

Several fuel elements could not be verified on that occasion because they were locked in a vault and the key could not be located. I have also learned from non-IAEA sources that Yahir el Mashad, the Egyptian-born scientist who was murdered in Paris last year, became a principal in the Iraqi nuclear program only after he had unsuccessfully advocated Egyptian production of nuclear weapons through the precise course the Iraqis apparently were pursuing.

Finally, an American inspector at the IAEA in the section responsible for Iraq, who has firsthand knowledge of the weakness of IAEA inspection procedures, resigned Tuesday. He has flown to Washington to present testimony to this committee on the Iraq program, in particular, and on the whole problem of the inadequacy of IAEA inspection safeguards, in general. He is Roger Richter. He will appear before this committee tomorrow morning.

I want to quote briefly from the analysis Mr. Richter provided the U.S. mission to the IAEA in 1980:

> The available information points to an aggressive, coordinated program by Iraq to develop a nuclear weapons capability during the next 5 years. The IAEA safeguards are totally incapable of detecting the production of plutonium in large-size material test reactors under the presently constituted safeguards arrangement.
>
> Perhaps the most disturbing implication of the Iraqi nuclear program is that the Non-Proliferation Treaty Agreement has had the effect of assisting Iraq in acquiring the nuclear technology and nuclear material for its program by absolving the cooperating nations of their moral responsibility by shifting it to the IAEA. These cooperating nations have thwarted concerted international criticism of their actions by pointing to Iraq signing of the Non-Proliferation Treaty while turning away from the numerous obvious and compelling evidence which leads to the conclusion that Iraq is embarked on a nuclear weapons program.

INTERNATIONAL APPROACH NOT WORKING

Mr. Chairman, the present international approach to controlling nuclear proliferation clearly is not working. The spread of the bomb presents the human race with our most fundamental challenge. The very survival of our civilization is placed at risk when the capacity to produce weapons of mass destruction is allowed to spread around the globe. We must all work together on this threat. There can be no more important task.

STATEMENT OF DR. HERBERT KOUTS, CHAIRMAN, DEPARTMENT OF NUCLEAR ENERGY, BROOKHAVEN NATIONAL LABORATORY, UPTON, N.Y.

Mr. Kouts. Thank you, Mr. Chairman.

I would like to begin, if it is all right with you, by reading a short prepared statement that I have. This is not particularly to shed light on the questions to be addressed by this panel, but to provide a background within which this could be done. It is, in fact, something which

I think should be said quite early in order to lend some balance to the discussion that we are having.

The Nuclear Non-Proliferation Treaty and the system of safeguards applied by the International Atomic Energy Agency are absolutely unique. This is the only international agreement in history in which a large fraction of the nations of the world have agreed to give up much of their sovereignty to an international body in the interest of peace on earth.

The Nuclear Non-Proliferation Treaty is a voluntary undertaking by countries that have nuclear weapons not to disseminate these weapons to other countries that do not have this capability. It is an undertaking by countries that do not have such weapons that they will not develop them.

It is also an undertaking by this last group of countries that they will submit to inspection by an international body—the IAEA—to permit verifying their compliance with the treaty. This is brand new in history. There are many treaties in history where nations give commitments, but do not go beyond giving the promise.

It is worth discussing some of the details of the system used by the IAEA in implementing its responsibilities under the treaty. The structure of this system is given in a document called Infcirc-153. It has the title, "The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons." I do not want to abstract this document, for that would be hard to do. But I can give some of the highlights.

IAEA safeguards are applied to all nuclear materials that could be used as or could be processed to become the essential explosive content of a nuclear explosive device. The document says that the safeguards are applied to all such material "in all peaceful nuclear activities," but as a practical matter, this means all material.

Safeguards are applied on the nuclear material, not on the facilities containing them. In practice, the application involves the facilities intimately because it is not unusually possible to separate one from the other.

The safeguards depend on accounting—accounting that the country itself sets up—and the IAEA has the responsibility of verifying the accounts. The country has to notify the IAEA when it receives any nuclear material, when it transfers nuclear material out of its jurisdiction, and when it uses material in certain ways that alter it.

The IAEA uses a system of verification that in many ways resembles auditing. It checks internal consistency of the information that it receives and the records that the country keeps. It conducts inspections that include verification of the inventory of the nuclear material as a function of where it is located. It even conducts independent measurements in some cases to verify what it has been told.

There also are additional rights held by IAEA and there are some restrictions on them. Among the rights are the ability to conduct some inspections without prior announcement. These are surprise inspections. The IAEA also inspects facilities at the start, to verify some details of their design, because these are important to the verifying of the accounts, too.

The restrictions are primarily limits on places the inspectors can go and limits on the rate at which inspections can take place.

The system and its effectiveness are of vital importance and they are primarily what we are talking about today. But I believe their importance has to be seen in the greater context of the functioning of the Non-Proliferation Treaty and the IAEA's general involvement.

It is very important to note, first of all, that the actual signing and ratification of the treaty are important steps in its effectiveness. Not all countries have signed up, by any means. Among the countries that have not signed up are most, by far, of the countries about which there has been concern regarding intentions as to nuclear weapons. The very act of not signing the treaty rings an alarm bell.

When a nation finally takes the step, signs and ratifies, there is a widely-felt state of relief. This does not prove that the objective has been accomplished, but violating the undertaking of a treaty is not a step casually taken, and that is particularly true of an undertaking not to produce nuclear weapons. Nuclear weapons are not popular in this world and seeing their manufacture in new places would not be popular, either.

Second and even more important, the information that becomes generally known just because safeguards are applied is of inestimable value. It is precisely this information which has been the subject of great discussion in the Iraqi case. It becomes known where the facilities are in a country and what they look like, where the material is to be found, in which form it is to be found, what uses are to be made of it, and so on.

This is all information which is required by the agency system. This is information which, if it had to be assembled through intelligence channels, would usually be fragmentary, self-contradictory, and perhaps misleading. Under the IAEA system, the information can even be verified by on-the-spot checking on a spot basis.

After all, the conclusions of IAEA inspections are only one part of the information base in nonproliferation. We have our own intelligence system and those of other countries too.

The significance of this system stands out more if we visualize what things would be like if we could use it elsewhere. A system of full revelation and inspection on the spot even at intervals would transform the SALT treaties, for instance.

Finally, there is also the chance that if the treaty were violated, the agency's systems would show this. This is a chance that politicians do not like to take. A covert violation is surely less likely under these circumstances than overt denunciation of the treaty or refusal to sign it in the first place. These acts would really ring the alarm bell. Measures that would lead a violator to take the overt path would be as fully effective as anything could possibly be.

The IAEA's system of safeguards cannot give 100-percent assurance in any case that any country to which that system is applied will not develop nuclear weapons capability. But that is not of absolute importance. The system is tailored very well to give advance information of suspicious actions and to permit the forces of political action to come into play.

This has been the objective of the whole enterprise from the first. No other objective is feasible or possible in a world where the basic facts of nuclear weaponry generally are known, where nature has widely endowed the world with mineral potential, and where nations remain sovereign.

The benefits of that degree of encroachment on sovereignty that has occurred with the Non-Proliferation Treaty and the IAEA system are of great value. I am sure that under the circumstances we cannot do appreciably better.

Now, that last remark, Mr. Chairman, really refers to the IAEA system in general and to the sovereignty which has been given up. How about the agency system itself? Of course, the agency's technical basis is not absolutely perfect; it can be improved. Measures which can be taken to improve the technical capability of the IAEA certainly will reinforce its political effectiveness. That is the context in which I am speaking.

Would it be possible for a country to circumvent agency methods to determine whether or not clandestine production of nuclear weapons would be taking place along the line that we have just heard? The answer is yes, it certainly is possible. It is always possible to develop scenarios in which a country can be successful in clandestinely developing its nuclear weapons capability.

Under the particular circumstances, probably the agency's technical methods would themselves not be effective. After all, they are based on material balance accounting. Those things that we know about the possibility of Iraqi development, whether or not they are significant, would not be investigated through material balance accounting. We know of these through other aspects of information gathered under the agency system, that is, what was taking place in Iraq at the time. That would be true in the future as well.

If there were clandestine development toward weaponry, this would probably require irradiation of uranium, of natural uranium or, if one could obtain it, depleted uranium, in a shield around the core of the reactor. This itself is a very difficult thing to do for engineering reasons and would require certain things that the agency inspectors certainly would observe, not as part of the material balance accounting but as part of the total information gathered on the site.

In order to irradiate this material, you have to heat it very much. This generates a lot of heat. The reactor core itself generates something between 40,000 kilowatts of heat and 70,000 kilowatts of heat. That is a pretty hot heat source and it requires a very large heat removal system.

The material you are irradiating on the outside probably will generate as much as 10 percent of that heat. That heat has to be taken away and that requires an engineering system whose presence would be observed or would very likely be observed. It would be very difficult to hide it.

Following that, you would have to take the material which is irradiated and move it to a place to process it. This requires heavy shielded containers, which also can be seen unless steps are taken to hide them.

Finally, in the processing itself, you generate a fission product burden in the environment whose presence can be detected by any number of methods, which also are not part of the agency system but presumably can accompany it. How long would a process of this kind take? Well, as Bob has just said, the whole process might take anywhere from a few years to a number of years.

To make the material in the first place in the Iraqi circumstances, it would take about 1 year to produce the material for a fissionable device, and about another year perhaps to put it into a form that would be useful, supposing you already have taken the steps to know how to do it, and an unknown period thereafter in order to turn this into weaponry.

The CHAIRMAN. Dr. Kouts, we thank you very much, indeed.

At this point, I will ask Senator Boschwitz to chair the hearing for a quarter of an hour or a half an hour. Senator Mathias has to chair a hearing at the Judiciary Committee and I must leave to testify on an Illinois highway program for about 15 to 20 minutes. I am sorry I have to leave, but I will return.

As our final witness on this panel, we will hear from Mr. Roger Richter, a former inspector for the Middle East Region of the International Atomic Energy Agency, whom the committee has called at the suggestion of Senator Cranston. Mr. Richter, we are happy to have you with us. Please proceed.

STATEMENT OF ROGER RICHTER

Mr. Chairman, it is both an honor and privilege for me to appear before the committee. It is my intention to present my views regarding the adequacy of the International Atomic Energy Agency (IAEA) safeguards system and how this system relates to the controversy surrounding the Iraqi nuclear program. As the only American inspector in the section responsible for the safeguarding of nuclear facilities in Iraq, Israel, Pakistan and India among other countries, I believe I have had a unique opportunity to gain an insight into the quality and effectiveness of the IAEA safeguards in a region of the world that is very much the focus of our Government's efforts to contain proliferation. The present heightened interest and concern on the part of the American people and the world community toward the effectiveness of the IAEA nuclear safeguards and nonproliferation efforts offers perhaps the best opportunity ever to identify deficiencies which exist in the system and to work toward resolving these deficiencies.

A principal objective of my testimony, Mr. Chairman, is to identify IAEA deficiencies and to strengthen what I believe to be the crucial mission of this most important international agency. The other principal objective is to explain why I believe that the Iraqi nuclear program was organized for the purpose of developing a capability to produce nuclear weapons over the next several years. By way of discussing these two subjects and their relations to one another, I thought it could best be accomplished by explaining them from the perspective of an IAEA safeguards inspector who is charged with the responsibility of safeguarding the Osirak reactor.

But first, by way of background, Mr. Chairman, I want to inform the Committee of my relevant experience in the field of nuclear engineering. I hold a B.S. in Metallurgical Engineering and M.S. in Nuclear Engineering from the Polytechnical Institute of New York and the University of Maryland. The latter degree was attained under the auspices of the U.S. Atomic Energy Commission select intern program. I have been employed by the U.S. AEC, ERDA, and DOE from June 1968 until February of 1978. During this time I was involved in nearly all aspects of the technology associated with nuclear fuel engineering, reactor irradiations and nuclear waste disposal.

While working for the Atomic Energy Commission, I have served as project engineer for the National Program to develop advanced fuel for breeder reactors, as a site representative at the General Electric breeder reactor headquarters in Sunnyvale, California and the Westinghouse nuclear component manufacturing facility also in Sunnyvale.

I have also authored a report for the U.S. Department of Energy San Francisco, operations office which was written at the request of the Federal Reserve Bank, on the economic impact of passage of proposition 15, and initiative which could have shut down the nuclear plants in California. This report was criticized by proponents of the initiative as being too pro-nuclear.

On the basis of these relevant experiences, I was offered a position as a nuclear safeguards inspector with the IAEA in February of 1978.

At the IAEA I initially served as an inspector in the Euratom section. I was a principal inspector at the nuclear fuel reprocessing facility in West Germany and at fuel fabrication facilities in both West Germany and Italy. I subsequently replaced the lone American inspector in the south and south/east section when he returned to the United States. I have been an active inspector in the south and south/east section for the past two years until my resignation on June 16, 1981. In this capacity, I have inspected small research reactors in Australia, Greece, Indonesia, Israel, the Philippines, Turkey and Yugoslavia. I have had considerable inspection experience with the heavy water power reactors Rapps 1 and 2 in Kota, India and the General Electric supplied light water reactors in Tarapur, India and at the nuclear fuel fabrication complex in Hyderabad, India.

I was recently involved in the final negotiations on behalf of the IAEA with the Government of India on the safeguard approach to the Prefre nuclear fuel reprocessing facility, located at the Tarapur site. I was to have been a key inspector in the implementation of the forthcoming inspections at the Prefre reprocessing plant later this year. I had in fact been offered, and I recently accepted, a five year extension of my present contract with the IAEA.

Now, I ask the members of the committee to imagine for the moment, that each of you is a nuclear safeguards inspector who will shortly be going to Iraq to conduct an inspection. To begin with, you have to imagine yourself as being a national of the Soviet Union or another eastern block country, or possibly also a Frenchman. Since 1976, all inspections performed in Iraq have been conducted by Soviet and Hungarian nationals. Recently a French national was granted approval by Iraq to be an inspector but he has not been to Iraq to make an inspection. This is a reflection of the fact that countries have the right to veto inspectors from whatever countries they choose; a right which they regularly exercise.

As an accepted inspector, you must keep in mind that any adverse conclusions you might reach as a result of your inspections would have to take into account your country's sensitivity to how this information might affect relations with Iraq.

In preparing for the inspection you must first give the Government of Iraq several weeks notice of your planned inspection and obtain a visa. They may agree with the date or could as has recently been the case, suggest you postpone or change your plans to a more suitable date. Naturally, not wanting to create unnecessary friction you will agree! You are now ready to go about the business of preparing yourself for the inspection. First you should become familiar with the design information Iraq has provided to the IAEA. You note that this design information is limited to describing the reactor, its operating characteristics such as power and flux, a description of the type and number of fuel elements and of the irradiation ports. The hot cells provided by Italy for examination and processing of irradiated nuclear specimens for possible plutonium separation, are not included in the information provided by Iraq, nor is the radiochemistry laboratory, pilot reprocessing facility or the fuel fabrication line included in the design information available to the IAEA.

These facilities are not under safeguards and so long as Iraq maintains that it is not processing plutonium or fabricating uranium fuel in these facilities, they will remain outside of safeguards. This may be disturbing to you as an IAEA inspector. Nevertheless, you are aware that as a signatory of NPT, only facilities which Iraq has declared to the IAEA as containing either thorium natural or depleted uranium in metal or oxide form of plutonium, are subject to your examination. However, natural uranium in the form of U_3O_8 commonly known as yellowcake is not subject to safeguards, despite its potential for easy conversion to target specimens for plutonium production. You are not entitled even to look at the other facilities if Iraq has not adhered to its obligation under NPT, to report to the IAEA that material subject to safeguards is located in these facilities. You are aware that the role of the inspector is limited to verifying only material declared by Iraq or France. You have no authority to look for undeclared material. Your job is to verify that the declared material accountancy balance is correct. The IAEA does not look for clandestine operations. The IAEA in effect conducts an accounting operation.

The amount and level of enrichment of the reactor fuel elements is indicated on your computer printout. But you notice that 100 tons of uranium in the form of U_3O_8 is not on the list.

This is not an oversight but a reflection of that fact that even though Portugal reported the shipment to the IAEA, it is only a formality. The 200,000 pounds of U_3O_8 is not subject to safeguards. Had this uranium been in a slightly reduced form such as UO_2, it would have been under safeguards; but this loophole could enable Iraq to do as it pleases with the U_3O_8. And so long as it does not report that the U_3O_8 has been converted into a material that is in the safeguarded category, you have no right to inquire of its whereabouts. You are disturbed by this because you realize that in the other Italian supplied fuel processing equipment which are not under safeguards, Iraq prossesses the capability to convert in a rather simple fashion the U_3O_8 to UO_2 or even better to uranium metal.

This could then be made into uranium targets which when bombarded by neutrons in the reactor core or blanket would be partially converted to plutonium. The targets could then be disassembled and reprocessed in the unsafeguarded hot cells and pilot reprocessing facility and the plutonium recovered. Since the U_3O_8 is not under safeguards, the material accountancy balance will not show that material has been withdrawn. The plutonium could therefore be accumulated without IAEA awareness. So long as Iraq does not live up to its obligation to admit to irradiating UO_2 or uranium metal in the reactor, you as an inspector have no recourse but to limit your inspection to the declared inventory.

As an inspector you have become aware that as much as 17-24 kg. of plutonium could be produced each year with the Osirak reactor. Even if only one-third of this amount was produced in the first few years of operation of the reactor through the use of the attendant processing facilities, Iraq could acquire a stockpile of plutonium sufficient to make several Atomic bombs. This is because in spite of having signed the NPT, the most sensitive facilities in the nuclear reactor complex could remain outside of the purview of the IAEA as long as Iraq did not declare that they contained either plutonium or uranium metal or oxide.

During these years when the plutonium stockpile is growing, Iraq could master the techniques of fabricating the plutonium configurations required for a nuclear weapon.

Equally disturbing to you as an inspector is the realization that under the present negotiated agreement between the IAEA and Iraq, you will be limited to only three inspections per year, usually spaced at approximately four month intervals. Since the entire reactor can be emptied of the clandestine uranium target specimens within days, you as an inspector face the fact that by the time you arrive to verify the declared inventory of fuel elements which power the reactor, all evidence of illicit irradiations could be covered up.

Furthermore, under the present safeguard approach for material test reactors such as Osirak, no use of T.V. or photographic surveillance is made. Such surveillance could possibly provide an indication of accelerated withdrawal of specimens from the reactor prior to an inspection. While it is recognized that such surveillance alone would not prevent clandestine plutonium production in the reactor, it could serve to reduce the ease by which the present laissez-faire approach to safeguarding large scale material test reactors allows for optimized production of plutonium 329 which has a low plutonium 240 content. Such low PU-240 fuel is ideal for nuclear bomb construction, particularly for a country whose bomb making capabilities are at an early stage of development.

In contrast to MTR's in light water nuclear power reactors it is comparatively very difficult to divert any of the plutonium generated during operation, and the high fuel exposure times lead to a buildup of the undesirable plutonium 240 isotope. This significantly increase the level of sophistication necessary to produce a useful bomb from light water power reactors and also greatly increases the difficulty of reprocessing the fuel for plutonuim recovery.

Moreover, unlike the light water nuclear power reactors where the IAEA TV and photographic surveillance have proven to be successful, MTR reactors do not readily lend themselves to unambiguous interpretation of surveillance results.

This is because in research reactors, the planned mode of operation is for frequent insertion and removal of experiments and radioisotopes. Consequently the cameras would only reveal the frequency and time when experiments were inserted and removed from the reactor, in between inspections. The amount of material removed and the nature of the material i.e.; are they isotopes for hospital use, or plutonium, could not be ascertained. However, given the low level of materials research activity in Iraq, such surveillance could provide an indication of whether the amount of material withdrawn from the reactor is far in excess of any conceivable experimental research program.

Faced with these obstacles and constraints, you may now be wondering exactly what does an inspector actually do in the course of performing a safeguard inspection of the Osirak nuclear complex. So much of the potential safeguarding activities are beyond the scope of your inspection and the most sensitive facilities in fact are not even subject to safeguards.

Your inspection assignment is actually quite narrowly focused. First, you will sit down with the operator of the nuclear reactor and review your computer listing of the nuclear material which has been declared to the IAEA. This inventory should correspond to the declared inventory appearing in the facility's listing.

France as supplier of the enriched uranium fuel will have notified the IAEA of the type and amount of fuel delivered to the reactor. You will determine that the amount recorded by the operator is consistent with the amount reported to the IAEA by France.

If there is new, unirradiated fuel in the inventory, you will measure the fuel with a stabilized assay meter to determine that the elements indeed contain enriched uranium and have not been replaced by dummy replica fuel. This is particularly important in the case of the Osirak fuel, since it would be a relatively easy matter to melt down the weapons grade highly enriched uranium fuel plates for use in a nuclear bomb. If the fuel elements are already in the reactor and have been irradiated, the inspection procedure normally requires that you visually identify the fuel elements. They can normally be observed under the approximately 20 feet of water. To confirm that these elements are not dummies, you have the right to ask the operator to turn on the reactor. When the reactor is operating, you should then see a characteristic blue glow known as "Cerenkov radiation" emanating from the core. This is indicative of operating radioactive fuel elements.

Having done these checks you have basically performed the most important elements of a nuclear safeguards inspection of a research reactor.

Thus far, this has been the easiest part of the inspection. The most difficult part lies ahead.

You will now return to Vienna and report that your inspection disclosed on discrepancies between the operator's records and that of the agency. You will report that you verified the unirradiated fuel with your stabilized assay meter and that you verified the irradiated fuel in the core by counting the elements and by virtue of seeing the reactor in operation. The difficult part of the job is that you must prepare yourself mentally to ignore the many signs that may indicate the presence of clandestine activities going on in the facilities adjacent to the reactor, facilities which you were not permitted to inspect, unless the host country has informed you that fuel elements from the reactor were transferred there. You will now complete a standard report, filling in the blanks, you will try to forget that you have just been party to a very misleading process.

It is partially the result of such feeling that I was prompted a year ago to write a report of my concerns about Osirak to the Department of State U.S. mission to the IAEA. With your permission Mr. Chairman, I would like to read a portion from that document.

"The available information points to an aggressive, coordinated program by Iraq to develop a nuclear weapons capability during the next five years.

"As a nuclear safeguards inspector at the IAEA, my concern and complaint is that Iraq will be able to conduct this program under the auspices of the Non-Proliferation Treaty and while violating the provisions of NPT. The IAEA safeguards are totally incapable of detecting the production of plutonium in large-size material test reactors under the presently constituted safeguards arrangements. Perhaps the most disturbing implication of the Iraqi nuclear program is that the NPT agreement has had the effect of assisting Iraq in acquiring the nuclear technology and nuclear material for its program by absolving the cooperating nations of their moral responsibility by shifting it to the IAEA. These cooperating nations have thwarted concerted international criticism of their actions by pointing to Iraq's signing of NPT, while turning away from the numerous, obvious and compelling evidence which leads to the conclusion that Iraq is embarked on a nuclear weapons program."

The U.S. mission representative indicated that he shared my concern and that he had forwarded my report to ACDA. He further indicated that ACDA was well aware of most of what I had reported and that an effort was being made to improve the IAEA approach to safeguards in Iraq. But as the most recent IAEA internal documents regarding these discussions show, there remains a very strong resistance to upgrading safeguards in the large scale research reactors, which constitute the most dangerous threat to nuclear nonproliferation. The time is now at hand to act. No better time is likely to exist in the future for improving the IAEA safeguards system.

There is no other viable substitute for the IAEA. It is a very necessary agency with perhaps the most important job of all international agencies. It employs highly competent, motivated and sincere people, nearly all of whom share the same ideals and goals with respect to nuclear nonproliferation.

But the IAEA has been hampered by narrowly focused rights to conduct inspections bestowed by the Member states. These rights need to be broadened and the IAEA must be enabled to conduct more comprehensive and better quality inspections. Each member state should ask itself whether its security and the collective security of the world community will be better served by improving the confidence and respect for the IAEA, or whether unbridled proliferation and short term commerical advantages should take precedence.

As Senator Cranston stated in his opening remarks before the Committee yesterday "The very survival of our civilization is placed at risk when the capacity to produce weapons of mass destruction is allowed to spread around the globe. We must all work together on this problem. There can be no more important task."

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IAEA PROGRAMS OF SAFEGUARDS

HEARING

BEFORE THE

COMMITTEE ON FOREIGN RELATIONS
UNITED STATES SENATE

NINETY-SEVENTH CONGRESS

FIRST SESSION

DECEMBER 2, 1981

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IAEA PROGRAMS OF SAFEGUARDS

WEDNESDAY, DECEMBER 2, 1981

UNITED STATES SENATE,
COMMITTEE ON FOREIGN RELATIONS,
Washington, D.C.

The committee met, pursuant to notice, at 10:37 a.m., in room 4221, Dirksen Senate Office Building, Hon. Charles H. Percy (chairman of the committee) presiding.

Present: Senators Percy, Biden, Glenn, and Cranston.

The CHAIRMAN. I call this meeting to order.

* * * *

This committee has previously had several days of hearings this year on various aspects of nuclear nonproliferation, including several sessions on the Israeli attack on the Iraqi reactor. The committee has had executive hearings and briefings on the Pakistani nuclear program. In addition, Senator Glenn and I are both members of the Energy Subcommittee on Governmental Affairs where I have chaired two hearings on various aspects of nuclear proliferation.

I cannot overemphasize how vital the control of nuclear weapons potential is to world peace and the survival of humankind. It is the most important single issue that any of us will deal with in our Senate careers in our lifetimes.

Today this hearing is focusing on one particular aspect of nuclear nonproliferation, the International Atomic Energy Agency [IAEA]. The Agency is so important to the success of the nuclear nonproliferation effort that it requires the most careful attention. It is the heart, it is the conscience of the Nuclear Non-Proliferation Treaty [NPT] and the international nuclear safeguards regime. It is the verification agency of the nuclear nonproliferation regime. The failure of the Agency to carry out its mission, unless a replacement should be found, would result in the dissolution of the Nuclear Non-Proliferation Treaty and undoubtedly lead to the spread of nuclear weapons.

There are increasing signs that the Agency is beset with technical and political problems. Technical problems include inadequate numbers and the quality of inspectors, inadequate monitoring equipment, and restrictions on inspectors. Some of these technical difficulties, of course, overlap into the political arena. One of the most serious problems in this respect is a tendency to politicize the IAEA on developed versus developing country grounds.

The developing nations often charge that the IAEA is a vehicle by which the developed nations restrict access to peaceful nuclear energy at the same time that they maintain enormous stockpiles of nuclear weapons. And, to be fair, it is true that the nuclear states have not fulfilled their promise in the NPT to reduce those stockpiles of weapons.

The developing states have, however, in my mind, gone in wrong directions, wrong for the peace of the world and wrong for the purpose and intent of IAEA, by pressing for unrealistic quotas of inspectors and influence in the Agency to which they bring few technical qualifications. I think it is contrary to the whole intent and purpose of this international organization to require quotas of people that may by simply inadequate for the job.

There are many criticisms of the IAEA and many that can be justified. The most resounding was delivered by the Israelis when they destroyed the nuclear reactor of Iraq. The Israelis, and for that matter, others, strongly suspected that Iraq intended to manufacture a nuclear weapon, and did not have confidence that the IAEA safeguards were sufficient either to reveal those intentions or prevent them from being realized.

More recently, there have been strong suspicions that Pakistan intends to manufacture a nuclear device, despite IAEA safeguards. Other nations give cause for serious concern.

Just last week, the Commissioners of the Nuclear Regulatory Commission [NRC] expressed their concern about the effectiveness of the IAEA.

I shall include without objection a copy of that letter of the NRC to Members of Congress in the record.

[The letter referred to follows:]

U.S. Nuclear Regulatory Commission,
Washington, D.C., November 27, 1981.

Hon. Larry Pressler,
Chairman, Subcommittee on Arms Control, Oceans and International Environment, Committee on Foreign Relations, U.S. Senate, Washington, D.C.

Dear Mr. Chairman: Over the past several years, Commissioners have expressed concern to the Congress regarding the adequacy of International Atomic Energy Agency (IAEA) safeguards. The Commission has noted that the NRC has had little or no safeguards information in making its export determinations under the Nuclear Nonproliferation Act.

In keeping with our responsibility to keep Congress fully and currently informed, we are writing to update our assessment of IAEA safeguards. The NRC is concerned that the IAEA safeguards system would not detect a diversion in at least some types of facilities. In addition, we are not confident that the member states would be notified of a diversion in a timely fashion. We are also communicating our concerns to the Executive Branch in the interests of helping to bring about improvements in IAEA safeguards.

We are reviewing our responsibilities under the Atomic Energy Act of 1954, as amended, for the licensing of nuclear exports in the light of these concerns and will inform you of our conclusions.

Sincerely,

Nunzio J. Palladino.

The **Chairman**. The letter indicates that the NRC will review its export policies for nuclear materials due to shadows cast upon the reliability of IAEA safeguards.

I would like to quote briefly from that letter:

> The NRC is concerned that the IAEA safeguard system would not detect a diversion in at least some types of facilities. In addition, we are not confident that the member states would be notified of a diversion in a timely fashion.

In light of these criticisms, there is obviously great need for a full scrutiny of the IAEA. Until confidence in the safeguards regime is restored, the Agency cannot carry out its functions to the satisfaction of the nations of the world. It certainly cannot serve as a model for an international verification agency for other types of arms control agreements unless these serious doubts are resolved. This hearing will constitute part of the congressional scrutiny of the IAEA. Frankly, I hope that we find that many of the criticisms are unfounded or exaggerated, for many of us have placed a great deal of hope in the ability of the IAEA to contribute to the control of nuclear weapons.

I am, however, after the truth of the matter and intend to hear all evidence and all testimony with objectivity.

I would not want to end this statement on too negative a note. If the political will exists—and I believe that it does—these problems can be resolved. I have seen no problem and no charge made against IAEA that cannot be somehow corrected. I believe and fervently hope that they are correctable, or we shall all have to undergo an agonizing analysis of possible alternatives.

We are fortunate to have specially qualified and capable witnesses today. I trust that they will provide constructive criticism and helpful suggestions.

STATEMENT OF SENATOR ALAN CRANSTON

Senator **Cranston**. Thank you.

I want first to thank you Mr. Chairman for granting my request to hold a hearing of this nature on this very important matter. I have been very deeply concerned that this committee has been receiving information about weaknesses in the IAEA safeguards system over a period of many months and years, but that this information has been brought forward only in the context of our consideration of other controversies of a more pressing nature.

Unfortunately, in the case both of the Israeli strike against Iraq and the lifting of nonproliferation sanctions against Pakistan, when this matter did come before us, this committee and the executive branch have been preoccupied with immediate concerns and unable to focus more intently on the dangers of reliance on inadequate IAEA safeguards for international security.

Unfortunate, too, has been the tendency of Reagan administration officials to make it a matter of policy not to inform Congress of new information regarding safeguard inadequacies when this information might raise questions about other administration programs. To be specific, I have been informed by several individuals that senior State Department officials reached a decision to limit congressional knowledge about troubling information on IAEA safeguards in Pakistan. This decision was taken in an apparent effort to secure congressional approval for the $3.2 billion package of aid and F-16 sales to Pakistan without having serious questions raised about the adequacy of international safeguards to detect and prevent a Pakistani nuclear bomb test.

I deplore this decision to cover up weaknesses in the IAEA system—which I believe ill-serves U.S. security interests and complicates what should be a cooperative effort between the executive and the legislative branches to improve vital nonproliferation safeguards.

By contrast, I want to commend the Nuclear Regulatory Commission for taking seriously its statutory obligation to keep Congress fully and currently informed on nuclear proliferation developments by notifying Congress last Friday of its concerns about IAEA safeguards. I believe the NRC's conclusion that IAEA safeguards do not appear adequate to detect diversions of sensitive nuclear materials in many facilities is a watershed event. Now the NRC has unanimously concluded, as many of us have before concluded, that the IAEA as presently constituted cannot do the two things it is mandated to do: detect diversions of sensitive nuclear material, and give timely warnings of any such diversions to the international community.

What the NRC has concluded in effect is that IAEA safeguards are not fully safe and do not guard effectively.

Mr. Chairman, it has been my experience that whatever serious questions are raised about the glaring weaknesses of the IAEA safeguards system, those who would push for greater international nuclear commerce are quick to declare: but there is no alternative to the IAEA. Twice this year former IAEA inspectors have come forward and expressed their deep concerns about safeguards inadequacies, and twice the State Department has responded with deliberate campaigns to discredit these individuals and to cast their conclusions as those of disgruntled former employees.

Further, open discussion of safeguards inadequacies has been hampered by the State Department's reflexive desire to classify and hold close any information which raises questions about the IAEA system. International safeguards against nuclear bomb development are too important for us to mute concerns about their ineffectiveness. Of course we must strengthen the IAEA, not tear it down, but it does no good whatsoever to pretend the emperor is finally clothed when it is clear to the unbiased eye that he is stark naked.

If we are to begin to solve the problems of the IAEA, we must first recognize what those problems are, and if we are to maintain the viability of international nuclear commerce, we must make absolutely certain that such commerce is not based on a false sense of confidence in a safeguard system that appears from all indications to be a house of cards.

Thank you, Mr. Chairman.

PREPARED STATEMENT OF HARRY R. FINLEY, ASSOCIATE DIRECTOR, INTERNATIONAL DIVISION, U.S. GENERAL ACCOUNTING OFFICE

Mr. Chairman and Members of the Committee, we are pleased to discuss with you our review of the nuclear safeguards applied by the International Atomic Energy Agency (IAEA) and the intensified U.S. effort to upgrade them. In our classified report issued earlier this year we presented a detailed assessment of IAEA safeguards and the intensified U.S. program to improve them.

It has long been recognized that both nuclear energy and nuclear weapons depend, in large measure, on the same technology and use much the same type of material and production facilities. To detect any diversion of U.S. nuclear material supplied abroad which might be used for other than peaceful purposes, the United States initially established its own bilateral safeguards system. However, with the inception of IAEA and the development of other nuclear suppliers, the United States phased out its bilateral program in favor of international safeguards.

IAEA was created in 1957 to accelerate and enlarge the contribution of nuclear energy to peace, health, and prosperity throughout the world without furthering any military purpose. One of its responsibilities is to administer an international safeguards system, but, as reflected in its budget, applying safeguards is not its primary function. (Only about 24 percent of IAEA's total resources are expected to be used for safeguards in 1982).

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EFFECTIVENESS OF SAFEGUARDS

The desired effects of IAEA safeguards are to (1) deter, through prompt detection, national diversions of safeguarded nuclear material; (2) place responsibility on the host country for instituting domestic programs to guard against subnational diversions (such as individuals or groups acting contrary to government policy); (3) reduce specific international tensions, by providing a degree of assurance among countries, especially hostile neighbors, that the safeguarded country is not developing nuclear explosive devices; and (4) insure that international nuclear commerce can be freely conducted without contributing to insecurity and tension among nations. IAEA hopes to apply safeguards with a high degree of reliability and assurance, within acceptable cost limits, and without unduly interfering with commercial operations.

The extent to which IAEA safeguards are considered effective is largely a matter of judgment. It would be difficult to prove whether or to what degree safeguards have achieved their desired effect. Effectiveness obviously involves many subtle factors such as the inhibiting effect that the mere application of IAEA safeguards might have on a nation harboring thoughts of a nuclear diversion. Nevertheless, it is clear that the credibility of international safeguards is basically dependent upon the probability of prompt detection. In many cases this probability of prompt detection needs to be increased.

We believe substantial improvements are required if the IAEA is to adequately fulfill its increasing safeguards responsibilities. The number of facilities and the amount of nuclear material under safeguards has increased rapidly in recent years. Many of the nuclear facilities now subject to safeguards are larger and more complex than those originally under safeguards. To meet its responsibilities, IAEA needs more technical, political, and budgetary support from its members.

International safeguards are a cornerstone of the non-proliferation regime. In essence, the United States and other nations around the world have placed great trust and reliance in the IAEA to deter would-be diverters and provide timely warning if safeguarded material is diverted. Before discussing the status of IAEA safeguards, it may be useful to point out the following facts about the scope of international safeguards.

The vast majority of nuclear facilities and material in non-nuclear weapons nations is subject to IAEA safeguards. However, membership in IAEA does not obligate a country to accept safeguards on all its facilities. For example, India, Israel, and South Africa have facilities not subject to IAEA safeguards. Pakistan is developing facilities which apparently will not be safeguarded.

Nuclear facilities of nuclear weapons countries are not subject to IAEA safeguards except on a voluntary basis. Of the nuclear weapons nations, the United Kingdom, France, and the United States have agreed to place their facilities—except those of direct national security significance—under IAEA safeguards. However, nuclear facilities in the Soviet Union and the People's Republic of China are not under safeguards. China is not even a member of IAEA.

IAEA inspectors do not have unlimited access on their inspections. They have no authority to pursue or recover diverted material. IAEA safeguards are not designed or intended to search for undeclared or clandestine facilities.

If an IAEA inspector cannot verify the non-diversion of nuclear material, the country must be given a "reasonable time" to take corrective action, before procedures for non-compliance may be initiated. Such procedures may include notification of member nations and the United Nations as well as the recall of IAEA-sponsored material. Although IAEA has never used these procedures, it seems clear that by the time sanctions could be applied, the country might have had sufficient time to complete its weapons development.

STATUS OF SAFEGUARDS

IAEA has reported that it has not detected any discrepancy which would indicate the diversion of a significant amount of safeguarded nulcear material, and has concluded that all such material remains in peaceful nuclear activities or is otherwise adequately accounted for. However, the degree of confidence that can be associated with current IAEA safeguards depends on such things as the amount, scope, and nature of the inspection effort.

International safeguards have reached different degrees of development for different types of facilities; in part, because IAEA experience in safeguarding certain types is considerably greater than for others. For example, IAEA has experience in safeguarding thermal power reactors (particularly light water reactors), but limited experience in safeguarding fast breeder reactors. Also, IAEA has experience in safeguarding certain bulk handling facilities—conversion and fabrication plants—but limited experience in applying safeguards to reprocessing and enrichment plants. Such plants are key to the proliferation issue because they provide direct access to weapons-usable material. The reason why IAEA has had limited experience in safeguarding certain facilities is that in general they are few in number and located primarily in nuclear weapons nations which have not been required under the Nuclear Non-Proliferation Treaty to place civil nuclear facilities under IAEA safeguards.

Several factors hinder IAEA in applying safeguards including (1) a limited number of inspectors, (2) a lack of suitable techniques and equipment, (3) inadequate nuclear material accounting practices by some nations, and (4) political constraints. Moreover, IAEA is experiencing financial constraints in performing its increasing safeguards responsibilities. It seems reasonable to conclude that IAEA's safeguards effectivness has been adversely influenced by these problems.

IAEA has an obligation under its safeguards agreements to conduct inspections. To fulfill its safeguards responsibilities, IAEA must have the necessary manpower to inspect, verify, and insure that a diversion of peaceful nuclear material has not taken place. However, the number of IAEA inspectors has not kept pace with its rapidly growing safeguards responsibilities.

The lack of suitable safeguards equipment is a primary reason why quantitative verifications in many cases cannot be adequately made. A substantial amount of material is in a form that is currently unmeasurable. While improvements have been made in recent years in the equipment to verify nuclear materials quantitatively, U.S. officials recently concluded that more reliable and suitable measurement equipment was needed by inspectors. In addition, containment and surveillance systems are not reliable for assuring the integrity of material control and accountability systems.

A nation is obligated to provide IAEA with accounting records and reports for all its nuclear material subject to safeguards. IAEA officials have repeatedly indicated a need for some nations to improve the quality of the nuclear material accountability information. To help alleviate these difficulties, the United States has provided training to officials of other nations in implementing national systems for the accounting and control of nuclear material.

Effective safeguards depend in large measure on the intent and cooperation of the host nation. In some cases, IAEA has had some difficulty in obtaining such cooperation. An example of this is the conditions established by some nations in consenting to the designation of inspectors. While it is the right of every nation to accept or reject a proposed inspector, there is the serious and growing practice of rejecting whole categories of proposed inspectors on political, linguistic, or nationalistic grounds. According to IAEA's Director General, this practice has unfortunately led to retaliatory discrimination, distortions of the recruiting pattern, and ineffective deployment of inspectors in the field.

The IAEA Statute provides that the cost of safeguards is to be apportioned among all member nations. The reason for this was that the imposition of international controls is in the interest of the world community. However, with the advent of the Nuclear Non-Proliferation Treaty, many members, particularly developing nations, were concerned that expected increases in safeguards expenses would have the effect of increasing assessed contributions and/or diminishing other IAEA programs. Because of mounting costs of safeguards and the controversy as to how these costs were to be met, a complex formula was developed in 1971. Since then, more than two-thirds of the member nations have been insulated from an increased financial responsibility for implementing new safeguards.

Of IAEA's 110 members, 74 contribute less than 2 percent of the funding for safeguards. For 1982, 31 members are being assessed about $750 for safeguards—the same as the lowest assessment made in 1971. Many member nations maintain that the financial resources of IAEA should be used primarily for technical assistance to less developed nations and to promote peaceful uses of nuclear energy. Thus, while many nations, in theory, fully support international safeguards, many are less supportive financially.

The United States has encouraged other member nations to render special assistance to IAEA in the technical aspects of safeguards. Several are now providing technical assistance to IAEA. These special assistance programs of member nations represent a commitment to improving safeguards, and further efforts should be encouraged. Nevertheless, such programs should not lead to the dilution of the basic premise that the cost of IAEA safeguards are to be apportioned among all member nations.

In July 1975, we reported that political, financial, technical and material accountability problems were being encountered in applying international safeguards. Since that time, efforts have been made to address some of these issues, but the magnitude of IAEA's safeguards responsibilities has outpaced these efforts and IAEA continues to encounter the same basic problems.

We believe a commitment by all member nations is needed if IAEA is to fulfill its increasing safeguards responsibilities.

U.S. EFFORTS TO UPGRADE INTERNATIONAL SAFEGUARDS

To help the Agency upgrade its safeguards system, President Ford, in 1976, pledged $1 million of special help annually for 5 years. In line with the President's pledge, the Department of Energy, the Arms Control and Disarmament Agency, the Nuclear Regulatory Commission, and the Department of State initiated a program of coordinated actions in support of Agency safeguards, including the Program of Technical Assistance to Safeguards.

This technical assistance program was originally to be of limited life and was intended to provide quick reaction to urgent needs, as identified by IAEA, to improve safeguards effectiveness where normal Agency budget channels could not respond fast enough.

From fiscal year 1977 through fiscal year 1981, the United States provided about $23 million through this special technical assistance program to improve international safeguards. In addition, the Department of Energy, the Arms Control and Disarmament Agency, and the Nuclear Regulatory Commission each have their own programs designed to support international safeguards. Since 1977, these agencies have expended a total of about $30.6 million on these programs. Nevertheless, U.S. officials stressed that the special U.S. assistance program has become the main vehicle for providing technical resources, funds, and other support to improve international safeguards as envisioned by the Nuclear Non-Proliferation Act of 1978.

United States and Agency officials did indicate that this special U.S. assistance program has helped the International Atomic Energy Agency but during our review, U.S. officials conceded that this special U.S. program had not yet had as significant an impact on actual safeguards implementation as had been hoped.

The most noteworthy accomplishments have been improved inspector training and a better information processing capability through improved data processing software and hardware. Cost-free experts, which supplement the Agency's staff, also have provided valuable assistance in the areas of equipment technology and the development of systems studies to improve safeguards techniques. The Agency's capability to verify some nuclear materials quantitatively was improved by the development of new instruments such as the neutron coincidence counter for plutonium.

Despite the progress made, most of the equipment resulting from the special U.S. assistance program was still in the evaluation and test stages and was not being used routinely on inspections at the time of our review. Inspectors complained that the system studies seem to be aimed at longer-term problems and not at solving current ones. It also appears that IAEA may not have the ability to absorb the results of some projects. Moreover, the IAEA has become much more dependent on the United States for support of safeguards improvements.

The procurement of new safeguards equipment and the expense of maintaining (and later replacing) such sophisticated equipment will probably become a significant factor. If IAEA does not have adequate resources in its budget, then IAEA dependence on the support of the United States and a few others may further increase.

SUPPORT FOR IMPROVING SAFEGUARDS SEEMS APPROPRIATE

Continued support to improve safeguards seems appropriate. The cost of safeguards is low compared to the costs of world insecurity and increased military weaponry. However, care must be exercised so that IAEA does not become too dependent on the United States for its support. To retain its character as an international organization, IAEA must receive technical, political, and financial support from all its members. Once the member nations are convinced that serious problems exist, they should demonstrate their support if they are truly committed to effective Agency safeguards.

NO CHANGE NEEDED IN U.S. LEGISLATION

The Nuclear Non-Proliferation Act of 1978 reaffirmed U.S. support to strengthen IAEA safeguards. In this regard, there appears to be no need to revise the U.S. legislation. However, the United States must get more member nations to recognize the serious limitations impeding the effective application of IAEA safeguards and to join together in resolving these problems.

IAEA is a unique international organization; the application of its safeguards program represents an exceptional concession of national sovereignty by safeguarded countries. There is no ready replacement for it, so efforts must be expended to improve the existing establishment.

This completes my statement, Mr. Chairman. We will answer any questions that you may have.

PREPARED STATEMENT OF VICTOR GILINSKY

I am pleased to be here this morning to testify on behalf of the Nuclear Regulatory Commission regarding the ability of the International Atomic Energy Agency to safeguard peaceful nuclear activities. As you know, the Commission's interest in this subject arises out of our responsibility for licensing the export of nuclear materials, facilities, and components. The Atomic Energy Act, as amended by the Nuclear Non-Proliferation Act of 1978 (NNPA), conditions the export of nuclear materials and facilities upon the Commission finding, among other things, that IAEA safeguards will be applied with respect to any such exports. In addition, the Commission must find that the export is not inimical to the common defense and security of the United States. While the Commissioners are not of one mind on the legal basis for inquiring into the adequacy of IAEA safeguards—two Commissioners have asked Congress to clarify the NNPA on this matter—they are unanimous that available information bearing on the adequacy of such safeguards in specific export cases must be taken into account.

In practice, the Commission obtains very little information about the details of the application of IAEA safeguards. In a February 1978 letter to this Committee, at the time of its consideration of the NNPA, Chairman Hendrie noted that the U.S. Government, including NRC, did not have direct access to country-specific information on IAEA safeguards effectiveness. This is still true.

The reasons for this stem from the origin of the IAEA. In order to ease the acceptance of international safeguards, the IAEA Statute provides that no "industrial secret or other confidential information" should be divulged to third parties by the IAEA. In practice, this prohibition has been interpreted in the broadest manner to withhold information about the details of the safeguards system. Thus, for example, the "subsidiary arrangements" and other documents related to the application of safeguards in a particular country or at a particular facility are not available to other member nations of the IAEA.

The Commission does receive some information, both unclassified and classified, on the application of IAEA safeguards from the Executive Branch and the IAEA. The IAEA publishes an annual report and provides its annual Safeguards Implementation Report (SIR) to each member of the Board of Governors. NRC obtains this document on a classified basis. The preparation of these reports is a step in the right direction. However, the Commission believes that more information should be reported to the Board by the IAEA Secretariat. We also believe that the United States should make every reasonable effort to gain better and more timely information on overall international safeguards effectiveness and on any significant safeguards problems in countries receiving U.S. exports.

In your letter inviting Commission testimony at this hearing, Mr. Chairman, you asked us to address the strengths and weaknesses of the IAEA safeguards

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[1] See page 2.

Senator John Glenn
204 Russell Office Building
Washington D.C. 20510 (202)224-3353
Ohio

(EXCERPT)

TEXT OF PREPARED OPENING STATEMENT BY SENATOR JOHN GLENN
HEARINGS BEFORE THE COMMITTEE ON FOREIGN RELATIONS
DECEMBER 2, 1981

Mr. Chairman, I consider the hearing today to be a significant event in this Committee's ongoing review of U.S. and worldwide nuclear nonproliferation efforts. The nuclear nonproliferation regime is a fragile one; its fragilities and flaws have become more apparent as years have gone by. In my view, Mr. Chairman, the world is in deep trouble on this issue and no recitation of cliches about how many nations were once predicted to become nuclear powers by 1981 but have not, will change that fact. We face a situation today where increasing numbers of nations are obtaining the capability to make nuclear weapons and some may have already done so or are in the process of doing so, whether they have tested devices or note. The technology of fission weapons has now reached the point where it really is not necessary for a nation to conduct nuclear tests in order to be reasonably assured that a constructed weapon will work.

To some extent the political pressures against overtesting can be considered one of the victories of the ongoing nonproliferation effort. But pressures against testing will not be sufficient to prevent the building of nuclear arsenals if sensitive technology is developed or transferred without stringent controls.

The international effort today rests on a slim reed - the safeguard system of the International Atomic Agency and all the auxiliary controls that have been built up by supplier nations over the years. We are going to hear a great deal of criticism about the IAEA safeguard system today and we will undoubtedly also hear a defense of the Agency. I am not one of those who feels that criticism of the Agency should be muted or supressed in order not to offend the sensibilities of some of its members. On the other hand, we must not lose sight of our aim -- which is to strengthen the safeguards system so that confidence in it can be regained and raised. To sweep the weaknesses of the Agency under the rug is to ultimately damage the nuclear enterprise -- for weaknesses in the system will not long stay hidden and public confidence can only come when there is widespread realization that the overseers of the safeguards system will resolutely identify all weaknesses and correct them.

Earlier this year Mr. Chairman, after our hearing on the Israeli raid on the Osriak Reactor, I made some recommendations regarding improvement of IAEA safeguards, some of which were incorporated in S. Res. 179 which passed the U.S. Senate by a vote of 88-0 on July 18, 1981. Among these recommendations were:

1. extending the concept of full-scope safeguards to mean safeguards on all nuclear materials, equipment, and facilities within a non-weapon state whether or not such materials, equipment, and facilities have been formerly declared to the IAEA.
2. increasing the quality and quantity of IAEA inspections, that means more man-power, more technical equipment for materials, accounting and surveillance, more unannounced visits to facilities.

3. publishing inspection reports.
4. extending and upgrading surveillance and containment measures.
5. putting limitations on the right of refusal of inspectors.
6. providing some degree of roaming rights for IAEA inspectors in order to enable them to look for suspected facilities and materials that have been undeclared.
7. establishing uniform national systems of materials accounting so that verification by the Agency can be enhanced. To all this must be added, restraint by suppliers in the deployment and transfer of nuclear facilities that strain the capabilities of the safeguards system. And finally, no system will be effective in the long-run if there is no presumption or certainty of sanctions for violators.

STATEMENT OF HON. GARY HART, A U.S. SENATOR FROM COLORADO

Senator HART. Mr. Chairman, may I add my word of thanks and congratulations to you and other members of the committee for scheduling and conducting these hearings, and my appreciation for having the opportunity to appear here.

There is no more important issue, in my judgment, than controlling the spread of nuclear weapons in the world; the focus on the inadequacy of the safeguards system that applies to nuclear technology and materials worldwide is, I think, among the most crucial responsibilities of the Congress of the United States. Just last week, as has been mentioned, the Nuclear Regulatory Commission made its concerns about these safeguards public.

Mr. Chairman, until those concerns are resolved, as ranking minority member of the Subcommittee on Nuclear Regulation, I would urge the NRC to suspend licensing of all exports of nuclear technology and materials, at least until it is confident that any diversion of nuclear material for weapons use can be detected. In light of the NRC's own admissions about the inadequacy of the safeguards system, it seems to me we can do no less.

You and other members of the committee have cited the NRC letter to several Members of Congress expressing its concerns that the current system is less than adequate, that the system would not detect a diversion in at least some types of facilities, and that the NRC has no confidence that member States would be notified of a diversion in a timely fashion. In short, the NRC has stated what many of us have suspected all along, and that is that we are placing our hopes of preventing the spread of nuclear weapons in a so-called safeguards system that is riddled with loopholes.

I think we have to consider three or four important facts of which many of you here today are aware. First, a nation can sign the Non-Proliferation Treaty, receive nuclear technology and substantial technical assistance, and then withdraw from the treaty and its safeguard systems on only 90 days notice.

Second, inspections which consist primarily of audits of inventory records—occur infrequently and are announced well in advance. This system leaves plenty of time for the undetected diversion of plutonium.

Third, when inspections do take place, inspectors are not only approved by the host country, they are restricted to facilities approved by the host country, and they are forbidden in many cases to look for or report clandestine nuclear activities, the very activities that they should be looking for.

And finally, in the event that some misuse of nuclear material or equipment, is detected, there is absolutely no guarantee of effective international sanctions.

This committee has already heard the disturbing testimony of the inspector who visited the Iraqi reactor just prior to the Israeli raid. He described how he had to use flashlights in some portions of that facility because adequate lighting was not available. He testified that keys were not available to areas of the reactor facility which may well have contained clandestine activities or unreported spent fuel. Indeed, his entire testimony underscored the existence of a system riddled with the kind of loopholes that I have mentioned.

The NRC I think deserves the commendation and support of the Congress for making its concerns about the safeguard systems public. I think more public discussion and a lot less secrecy may well force the upgrading of the safeguard system that so many of us feel is so urgently needed.

But right now, as they stand, those so-called safeguards are not sufficient to make the world community safe—and they do not guard against the spread of nuclear weapons. The safeguards are little more than a facade, and while they legitimize nuclear trade, they place the world in ever greater danger from the undetected misuse of nuclear weapons.

The NRC assessment of the international safeguard system leaves the United States with a very difficult choice: Should it abandon the IAEA altogether, or should it take steps necessary to make that agency an effective policeman of world nuclear activities? I think most of us favor the latter approach. If we abandon that agency, we will have nothing with which to replace it, and consequently, will certaintly fail in our efforts to prevent the spread of nuclear weapons.

I think the IAEA performs an important and vital role. The United States and other countries must recognize the agency's political and technical weaknesses, however, and in a concerted and sustained effort rebuild and strengthen that agency so that the world community will have confidence in the ability of safeguards to detect misuses of nuclear materials and equipment.

But as I indicated at the outset, Mr. Chairman, I think there is one step that this country and its appropriate agencies should take forthwith: to urge the NRC to suspend all export of nuclear materials and technology until we can have confidence that the diversion of that material can be detected. That is the very least our Government—and the agencies responsible for protecting human lives—can do.

I appreciate the opportunity to be here today.

The **Chairman**. We appreciate very much the leadership you have always exerted in this field, and we want to work very closely with you. There are overlapping committee jurisdictions sometimes, but we try to divide them cleanly. Senator Glenn and I both serve on Governmental Affairs where we have the Nonproliferation Subcommittee that we share, and we will work very closely with you.

And I want to thank Senator Cranston very much for suggesting this hearing today.

Thank you very much.

Senator **Cranston**. Thank you, Mr. Chairman.

PREPARED STATEMENT OF HON. RICHARD T. KENNEDY

Mr. Chairman, it is a pleasure to appear before you today to discuss the International Atomic Energy Agency (IAEA) safeguards system. I particularly welcome this opportunity because of the interest and involvement of this committee in the nuclear non-proliferation problem. A careful examination of this subject is especially timely.

I will briefly cover the nature of IAEA safeguards and their role in the non-proliferation regime. I will also briefly discuss the effectiveness of these safeguards, and will outline the continuing work underway to improve them.

It is important at the outset to understand what IAEA safeguards are and what they are not. They are a system of procedures including records, reports, and inspections, by which the IAEA can verify that specified material and facilities are not being diverted from their declared peaceful purposes. IAEA safeguards are a critical and indispensible component of the worldwide non-proliferation effort. But they are not the totality of that effort.

IAEA safeguards are principally a detection and warning rather than a prevention or reaction mechanism. The IAEA has no capability to physically prevent diversion and has limited enforcement authority. The IAEA has no authority or capability to search for nuclear activities away from defined locations. And IAEA safeguards do not involve political judgements by the IAEA as to the dependability or sincerity of non-proliferation commitments.

There also are clear limitations on how the IAEA can fulfill the specific tasks with which it is entrusted. The Agency does not have power, for example, to demand plant shutdowns. The Agency's rights on a range of specific questions (such as designation of inspectors) are subject to limitations. Substantial amounts of information received or collected by the IAEA are classified and thus not publicly releaseable by the IAEA.

These points have sometimes been cited as criticisms of the IAEA. However, the general limitations on the Agency's role are simply facts of international relations, understood from the outset by all concerned. The IAEA safeguards system entails a unique compromise of sovereign rights by many nations, and it is certainly no surprise that this compromise is subject to specific limitations. We must assure that IAEA safeguards do accomplish their defined role, while pursuing other elements of non-proliferation policy such as intelligence efforts, security relationships, treaty commitments (particularly the NPT), restraint in supply of sensitive nuclear material and technology, and upgrading national physical protection capabilities, to deal with aspects of the problem not addressed by IAEA safeguards.

With regard to the specific safeguards rights and activities of the IAEA and to the question of the Agency's effectiveness, I do not believe an abstract listing of limitations is the best approach to analysis or evaluation. Rather we should ask the following questions:

Does the IAEA have an adequate legal basis for application of effective safeguards?

Do the detailed arrangements reflect an appropriate balance of effectiveness of safeguards and protection of the valid economic, safety, and proprietary interests of the operators?

Does the IAEA have the motivation, means, and capabilities to implement reasonably effective safeguards?

Does the political context in which IAEA safeguards operate allow the effective implementation of its inspection, analysis, and reporting functions?

I believe the answer to all these questions is generally yes. But actual in-the-field application, while improving, is uneven and often falls short of what should, in principle, be done. It has taken sustained efforts by the United States and other interested countries to achieve the progress to date; and there are problems and weaknesses which need further work to improve the agency's effectiveness and to keep pace with nuclear power developments.

A careful analysis of each of the above questions, a presentation of the reasoning behind our generally, positive conclusion, and a complete listing of necessary improvements is beyond the scope of my remarks here. But I would like to present some of the relevant background and considerations.

The IAEA's task has been rapidly changing, both quantitatively and qualitatively. IAEA safeguards were initially, applied mainly to research reactors, then to an increasing number of power reactors. The safeguards task in the case or research reactors and light water moderated power reactors was relatively straightforward: The counting and identification of a modest number of discrete fuel elements. Also, exact technical standards for safeguards were not provided.

In recent years, IAEA safeguards have been applied to a rapidly increasing number of states and facilities. Perhaps more importantly, some of the safeguarded facilities have presented a much more complex safeguards problem. Large amounts of material in various forms are present in or flow through "bulk handling" facilities. In particular, fuel fabrication, reprocessing, and enrichment plants pose substantial challenges for IAEA safeguards. Also, on-line refueled power reactors pose more complex safeguards problems than do other types, because of continuous fuel movements. The political context of safeguards has in some ways also become more sensitive, particularly, with the spread of significant nuclear facilities to regions of possible proliferation risk.

The U.S. effort in the safeguards area has had several main components. First, we have engaged in a concerted effort over several years to persuade the IAEA to design its safeguards approaches to counter specific diversion scenarios. We also have supported the establishment of safeguards detection goals, in terms of quantities and times. Only with such goals can uniform and effective safeguards procedures be established. This effort has largely succeeded. The IAEA has adopted this diversion-scenario orientation, and a very demanding set of goals. These goals are to some degree arbitrary and are not accepted (or even appropriate) as formal requirements. But their use represents clear progress in the IAEA's concept of its task.

Second, we have pressed for more regular and self-critical analysis by the Agency secretariat of inspection results. We believe this is crucial both to identification of necessary improvements and to informative reporting by the IAEA to its Board of Governors. A major step in this connection was the establishment, in the last few years, of a highly competent internal evaluation unit, and the preparation of an annual safeguards implementation report. This report provides extensive information on safeguards activities at specific facility types, on the degree of achievement of objectives, and on improvements needed. The Director General also has increased his specific reporting to the Board of Governors on matters of safeguards interest.

Third, we have supported a sharp increase in safeguards resources. The increase in the safeguards staff has been very rapid over the last several years, going from 100 in 1976 to 220 in 1981. The budget for safeguards has increased from $6.4 million to $25 million in that period. An extensive U.S. program of technical support to the IAEA is now paying off in the procurement and field use of some 10 types of safeguards instruments, as well as in the application of various systems studies, data handling systems and standardization efforts. This U.S. support program has helped to induce several other countries, including the United Kingdom, Germany, Canada, and the Soviet Union, to institute similar measures.

Other elements of our effort have included support for appointment of competent and highly motivated staff. In this connection, we are pleased that the IAEA has recently appointed an extremely capable Director General, Mr. Hans Blix of Sweden, to succeed the long time distinguished Director General Dr. Sigvard Eklund. The United States also makes Diplomatic approaches to encourage other countries to increase their support of effective IAEA safeguards.

Turning to whether IAEA safeguards agreements provide an adequate basis for effective safeguards exists, some further background is relevant. When cooperation in peaceful nuclear power started in a serious way in the late 1950's, the United States made extensive supply arrangements which provided us rights to inspect the supplied items to assure that they had not been diverted from peaceful purposes. The IAEA was established in 1957 and empowered to apply safeguards to items supplied through it and in other cases as requested. The IAEA's safeguards rights and responsibilities are not set out in a single world-wide instrument but are established under agreements between individual states and the IAEA. These can be either trilateral agreements (a supplier, a recipient, and the IAEA) or bilateral agreements, involving only the inspected state and the IAEA. Since the entry into force of the Non-Proliferation Treaty, over 100 states have concluded bilateral safeguards agreements with the IAEA covering all nuclear activities in the state.

Safeguards agreements pursuant to the NPT all closely follow an extensively negotiated model agreement. It provides an adequate basis for safeguards application. It also provides various provisions which deal with potential concerns of operators. The older guidelines for non-NPT type agreements are less specific on many points such as objectives of safeguards. These agreements do not limit inspection man-days. Some early agreements had deficiencies such as inadequate provisions with regard to duration of the agreement. Such deficiencies have been corrected in recent non-NPT agreements, and we are satisfied that they too provide an adequate basis for safeguards application.

Under either type of safeguards agreement more detailed safeguards arrangements are worked out for individual facilities. These, unlike the basic agreements, are not public documents. Our understanding is that provisions in these "facility attachments" have evolved and improved over time. For example, older ones in some cases did not provide explicitly for use of safeguards equipment such as cameras. But parties to these early agreements have generally accepted that technical advances should be applied under existing agreements. Also, these documents can be amended by the state and IAEA; and the IAEA frequently requests such updating. We believe that this updating has had considerable success. Nevertheless improvement of some old arrangements still is necessary. Based on our present understanding, recent and updated facility attachments are designed to address the relevant diversion scenarios and do provide the IAEA with adequate rights and means to apply safeguards. For example, at several bulk handling facilities continuous inspection is permitted.

Some perspective is necessary in reacting to certain recent criticisms of the legal provisions in the IAEA system. For example, the fact that inspected states must agree to the designation of individual inspectors has been presented as a major defect. We do not believe this is the case. Operators or inspected states have a legitimate interest in being able to avoid the designation of individuals objectionable to them, for example for physical security reasons. In fact, the U.S. Senate considered this provision to be an important protection for the United States under our own safeguards agreement with the IAEA. Safeguards agreements also contain a provision protecting against overuse of the right to refuse designation of an inspector. In practice, designation of inspectors, has not been a widespread or serious problem to the IAEA, and has not prevented inspections of any state or facility. However, the Director General has reported to the board that delays in acceptance of inspectors in some instances have complicated the IAEA's task by preventing optimal use of manpower.

With regard to the motivation, resources, and capability of the IAEA to apply effective safeguards, I have outlined the increases in staff and budget. A measure of the adequacy of the resources available is the comparison of inspection provisions in facility attachments to actual implemented inspections. Of those inspection man-days provided in the facility attachments, only about 50 percent have been implemented in the last year due in large part to resource limitations. This is a situation clearly needing improvement. The IAEA projects approximately 70 percent implementation in the next year or two, and we strongly support efforts toward that end.

The top management of the IAEA is highly competent and motivated, and there are many excellent and committed staff at all levels. But as with any large organization, there can be improvements to assure against significant mistakes or omissions by staff in the conduct of inspections and analyses it is important that adequate redundancies and crosschecks are built into the system. While more remains to be done, the IAEA is making progress in this regard. The establishment of the evaluation unit mentioned earlier is a case in point. We expect the new Director General to continue the improvements of IAEA efficiency and effectiveness.

The political context for IAEA safeguards also is critical. There are many considerations such as degree of cooperation from inspected states, any vulnerability of individual inspectors to political pressure, ability of IAEA management resist possible pressure from inspected states on specific points, and general support of safeguards functions by the Board of Governors. Detailed discussion of each of these factors is not possible in the time available. The overall situation with regard to such factors, however, is good. Inspected states, for example, generally are quite cooperative. In those cases where a state may not be cooperative, the Director General can have confidence he will be backed by a large majority of the Board of Governors. The Board plays a very important role in policymaking, and its present size and composition allows effective functioning in this regard. And the IAEA staff performs well in terms of reporting to the Board on difficulties encountered. The IAEA Secretariat also is able to resist pressure to dismiss individual inspectors, and thus to provide reasonable job security.

Differences between the developing and developed countries increasingly are evident in the IAEA. The G-77 countries are pressing for expansion of the Board of Governors, increased technical assistance funded as a regular budget item, and more hiring of individuals from developing countries for positions within the IAEA Secretariat. Where the developing countries can make a reasonble case for change, such as in more consideration of qualified individuals from these countries in IAEA appointments, I believe we should be responsive. But we must also make clear from the start our opposition to changes which would weaken the IAEA's ability to perform its functions. We have opposed changing current voluntary funding of technical assistance and we have opposed any further expansion of the Board.

Not least we need to resist the intrusion into IAEA matters of extraneous political factors, as occurred last September when the general conference debated whether to suspend Israel from the IAEA. Such politicization ultimately could threaten the ability of the IAEA to perform its tasks, and especially its vital safeguard mission. For now, however, these disputes have not undermined safeguards and we are guardedly optimistic that a large majority of IAEA member states will continue to recognize that an effective IAEA is in their own security interest and is an indispensible requirement for the expanded international nuclear commerce many of them seek.

It sometimes is suggested that there is a contradiction between the safeguards and "promotional" functions of the IAEA. I do not believe this so. The IAEA is not an operator of activities which it safeguards; nor does it have an economic interest in them. The IAEA's "promotional" programs provide basic information in areas such as reactor safety, waste management, or reactor siting or involve relatively modest technical assistance projects. These IAEA programs are one way of implementing article IV of the nuclear Non-Proliferation Treaty which committed the developed countries to aid the developing ones in acquiring the benefits of nuclear energy. In the eyes of many of these developing countries such IAEA participation and assistance, therefore, is a necessary part of the broader non-proliferation bargain. Thus, rather than weakening the safeguards system, so-called "promotional" programs help to maintain the global political support that the system assumes.

Mr. Chairman, President Reagan has made clear that we strongly support the IAEA. We must continue to recognize the unique nature and contribution of this international body. We have taken various steps and plan to take still others to strengthen the Agency. And very important progress has been made by the IAEA in the recent past. But the IAEA still confronts important problems. Our objective, in support of the new Director General, must be to make it as good and effective an organization as possible, recognizing the continual need to do even better. I warmly welcome the past and present interest of this committee in IAEA safeguards, and will work closely with you in the continued support and further improvement of this essential element of our non-proliferation effort.

PREPARED STATEMENT OF EMANUEL R. MORGAN

Thank you, Chairman Percy, for the opportunity to testify before this Committee regarding the ability of the IAEA to effectively safeguard nuclear material. A sober evaluation of the actual effectiveness of IAEA safeguards bears heavily upon vital non-proliferation and international security issues.

Before proceeding, I'd like to give you a brief idea of the background that I bring to this hearing. This includes a bachelor's degree in chemistry and graduate studies in business administration and statistics.

I have worked for 15 years in the area of safeguarding nuclear materials. From April 1967 until July 1968, I was employed as a chemist with NUMEC, Atlantic Richfield Chemical Company. From August 1968 until October 1975, I worked as a safeguard inspector with the Atomic Energy Commission and its successor, the Nuclear Regulatory Commission. From October 1975 to April 1977, I worked with the Nuclear Regulatory Commission in materials and plant protection standards. From May 1977 until August 1980, I was employed as a safeguards inspector with the International Atomic Energy Agency in the Euratom and Far East sections. From September 1980 until July 1981, I was employed by the Nuclear Regulatory Commission Office of Standards Development and Nuclear Regulatory Research, Safeguards Branch, as a statistician and material control analyst. I left the Nuclear Regulatory Commission last July and am now in private business.

Throughout this 15-year period in the field of nuclear materials safeguards, I was neither an advocate nor an opponent of nuclear energy. I am testifying as a private citizen, primarily with regard to the technical merits of IAEA safeguards as I know them at the time of my service in Vienna from 1977 through 1980.

Prior to my leaving the NRC last July, I wrote a report on IAEA safeguards at the request of Commissioner Victor Gilinsky. This report has unfortunately and inexplicably been released to the news media and has been the subject of media comments, some uncharitable, by unidentified officials. I personally have refused to respond to these comments and do not condone the release of an official classified report written for internal U.S. Government use.

It is my opinion and it is my testimony this morning that the fundamental objective of IAEA safeguards, to detect diversion of sensitive nuclear materials, cannot presently be met and will not be met in the forseeable future. There is clear evidence of the fact that safeguards are not being met in the IAEA's Safeguards Implementation Reports, published annually for the years 1976 to 1980. These reports identify numerous gaps in the safeguards system, but inexplicabiy conclude that there has been no diversion of sensitive nuclear materials. It appears to me that most U.S. officials are not aware of the degree of inadequacy of IAEA safeguards.

There are four principal reasons why agency safeguards are ineffective, namely:

1. The IAEA has basic structural limitations;
2. The IAEA has inadequate resources;
3. There is insufficient cooperation with the IAEA on the part of facility operators and member states;
4. There are shortcomings in the implementation of safeguards by the IAEA.

STRUCTURAL LIMITATIONS

The structural limitations concern the relatively immutable aspects of IAEA safeguards.

First, IAEA safeguards are aimed at the control of certain weapons usable materials, namely high enriched uranium and plutonium; and certain indirect-use materials, namely low-enriched, normal and depleted uranium and thorium, which can be converted to weapons usable materials. IAEA safeguards do not apply to uranium and thorium ores, and a number of other materials, which could be used to produce weapons usable materials.

Second, under the NPT, the IAEA does not safeguard facilities, but only nuclear material at certain strategic points within a facility identified by design information submitted by a State, and agreed to by the State, as necessary points to apply safeguards. Accordingly, the IAEA does not have free access within a facility and does not seek to discover hidden or undeclared nuclear material or equipment or to discover undeclared installations. It thus has severely limited powers.

Third, IAEA does not have the freedom to designate which and how many inspectors it wants to send to inspect a facility. A state can impede the application of safeguards by limiting the acceptance of inspectors. In the case of a small state, as few as four inspectors may be designated for the state, not all of whom may visit the state in a given year. The state can delay the acceptance of a new inspector by failing to act on the IAEA proposal for designation or refuse to accept it.

A fourth structural limitation lies in the limited effectiveness of simple accountancy as a safeguards measure of fundamental importance.

This is true for two reasons. One is that measurements are not perfect, and therefore the operator may report an apparent loss or the IAEA may discover one through verification that appears to be a possible diversion, but which in fact is the result of inaccuracies of measurement. In fact, the accumulation of inaccuracies of measurement may be so great, particularly where large amounts of material are processed, that it is impossible to detect the diversion for military purposes of a significant quantity of nuclear material.

The second reason is that mistakes and accidental losses do occur. These cannot be distinguished from possible diversions. Further, when an indication of a possible diversion occurs, the IAEA must assume that it could be an indication that diversion is occurring at many different locations within an inspected country. Since such indications occur frequently, and since the IAEA cannot fully investigate every one by reinventorying the entire country, the IAEA is in fact not capable of detecting diversions nearly as effectively as many believe it can.

Another structural problem concerns enforcement action. In the case of a diversion which is not corrected in a reasonable period of time, the IAEA is permitted to take the matter before the U.N. Security Council and General Assembly. In the case of a simple failure of a country to cooperate with IAEA safeguards, there is virtually nothing that the IAEA can do to achieve corrective action.

Many states do not have their own systems of accounting and control which meet IAEA guidelines. But little can be done by the IAEA to achieve compliance.

Other limitations of a quasi-structural nature are the various concessions that the IAEA has made to certain states which serve as precedents and which constrain the effectiveness of subsequent agency agreements with other countries. These agreements permit such effectiveness-limiting practices as inspection by observation only, the joint team approach, no "less favorable treatment," and memoranda of understanding that seriously reduce the scope of inspections.

Finally, one can consider the dual promotional and regulatory roles of the IAEA to be a structural limitation. A similar situation resulted in the splitting of the U.S. Atomic Energy Commission into two separate agencies. In fact, one stated role of IAEA safeguards is the facilitation of nuclear commerce.

RESOURCES

The second basic reason that IAEA safeguards are ineffective has to do with resources. It is not possible for the IAEA to carry out as many thorough inspections as are considered necessary, due to insufficient inspector manpower, funds, support staff and equipment.

With regard to staff, it is recognized that the United States and other countries provide experts to the IAEA. But these experts are not permitted access to inspection data.

The IAEA would benefit by the addition of research staff and expansion of the staff supporting analysis of inspection data. The scope of the internal audits also should be expanded to permit reviews of the adequacy of inspections.

COOPERATION

The third reason safeguards are inadequate is because of insufficient cooperation from inspected states and facility operators. Many examples of lack of cooperation can be cited. Their end effect is to reduce the effectiveness of safeguards. There have been many cases where the views of the IAEA and of inspected states have been in conflict. Such issues have included access to records and facilities, charges for services, the taking and shipment of samples, and the scheduling of activities. Many times states have refused inspectors' efforts to verify design information. This is despite the fact that the IAEA has reached agreement on subsidiary arrangements with states which require a complete design information review.

In the case of the U.S. mission to the IAEA, it was my experience that the mission did little to improve cooperation on the part of states with the IAEA. For example, one U.S. inspector waited nearly a year for his designation to be accepted by a country that happened to be friendly to the United States. Inspectors noted that the U.S. mission was helpful in the area of financial assistance to the IAEA, but not in support of the inspection staff per se.

In response to criticism by U.S. inspectors, the U.S. Mission commissioned an audit of the Division of Safeguards. The U.S. Mission should be complemented for this action.

SHORTCOMINGS IN SAFEGUARDS IMPLEMENTATION

The fourth reason why agency safeguards are ineffective simply is that there are shortcomings in the implementation of the safeguards. Arrangements for the application of safeguards at the facility level are not adequate. The IAEA has been too flexible in negotiating the actual time permitted for inspectors to conduct inspections. The amount of time countries allow for inspections may be much lower than the maximum suggested by published IAEA guidelines. There may be no provision for necessary activities, such as detailed chemical analysis of such samples as suspect finished fuel rods and fuel elements despite the fact that such analysis may be the only way to determine whether the stated quantity of nuclear material is present. The manager of the facility being inspected may simply refuse to ship samples to the IAEA laboratory.

There may be no requirement in the negotiated safeguards agreement for a complete list, containing necessary data, of items in inventory which must be available for the IAEA inspector to verify a physical inventory.

In the area of containment and surveillance, devices such as seals and cameras are employed to detect some diversion scenarios. For example, cameras in a power reactor snap pictures of a fuel pond at intervals intended to protect against a possible diversion of a heavy cask containing fuel. But there may be no protection against less likely scenarios, such as shuttle system not visible from camera's vantage point in the fuel pond. Also cameras and seals are far from foolproof. The longer that a particular device is in use, the more likely it is that an operator attempting to divert material would be able to develop counter-measures to defeat it. Yet the IAEA is using seals that were in use 10 years ago. And some countries reserve the right to approve or reject new monitoring devices.

In safeguarding against the breeding of plutonium or uranium-233 in an undeclared blanket or in the structural components of the core of a reactor, the IAEA does little. The IAEA does not monitor reactor operating parameters and does not have, in cases of which I am aware, access to the control room.

Also, the IAEA does not verify the electrical output of reactors. This information would be valuable to confirm the quantities of plutonium produced. Burnup calculations are not verified and isotopic correlation techniques are not applied, except in the case of a few development studies unrelated to safeguards inspections.

The IAEA has found it virtually impossible to do transit accounting, that is, to check whether facility B received the material that facility A said it sent there. As a result, verification of records and reports is done primarily by checking the internal consistency of an individual facility's statement, without corroborating that statement with statements of other facilities that shipped to or received from the facility under review.

Additionally, the IAEA has usually not been able to calculate the uncertainty of material unaccounted for, pursuant to the IAEA's statutory mandate. This calculation would be useful because it would give the IAEA an idea of permissible limits for material unaccounted for, pursuant to the IAEA's statutory mandate. This calculation would be useful because it would give the IAEA an idea of permissible limits for material unaccounted for. This calculation is not presently performed.

Other inadequately covered routes of possible diversion include waste streams and retained waste.

At the present time, there is no agreement within the IAEA with regard to a list of possible ways of diverting nuclear materials the agency must attempt to detect. As a result, this question is left to the individual inspector's answer. Often, the country and operator are given the benefit of the doubt.

Although the IAEA is primarily concerned with accounting, for the three years that I was employed there, the agency did not have a single professional accountant on the staff of the Division of Safeguards.

There is no formal language training for inspectors, although individual inspectors have provided private assistance to one another. The IAEA does have an evening language program for employees and their spouses, but this is limited to German and four of the five UN working languages, on a one evening per week basis. That did not help me with Japanese, for example. As a result, inspectors' communication with operators is difficult at best.

Finally, I would observe that the IAEA is constantly concerned for the confidentiality of commercial information that frequently is not warranted. States and operators have frequently used this justification for limiting the scope of inspection activities. This false "confidentiality" has also tended to cloak the IAEA's shortcomings. I believe greater transparency should be sought if the IAEA is to convince doubters of its value as a safeguards agency.

SUMMARY

In summary, and in due respect for the many very fine individuals who are employed by the IAEA, it is my considered opinion that IAEA safeguards, against the diversion of sensitive nuclear materials, are not presently effective and will not be effective in the foreseeable future. Perhaps the problem is simply bigger than IAEA's ability to deal with it.

TESTIMONY OF DR. THOMAS E. SHEA, FORMER SAFEGUARDS ANALYST AND INSPECTOR, IAEA, AND VICE PRESIDENT, INET CORP., SUNNYVALE, CALIF.

Mr. SHEA. Thank you, Senator.

Senator, I was with the International Atomic Energy Agency from March 1977 until July 1981. I joined the Agency as a first officer in the Systems Study Section in the Department of Safeguards and in July 1979 was promoted to senior officer in that section. I remained at the Agency a total of 4 years and 4 months, leaving this last July to start a business.

My service with the Agency was such that I had an opportunity to contribute to solving a wide variety of problems ranging from generic policy issues to very specific problems concerning the implementation of Agency safeguards at specific facilities throughout the world. I would like to mention three areas of particular involvement.

First: The Agency's Deputy Director General for Safeguards is advised by an internal technical review group on matters related to safeguards documents under negotiation, especially subsidiary arrangements and facility attachments. I was privileged to represent the Division of Development during the 4 years that I was in that particular group, and was involved in the safeguards attachments for research reactors in Iraq, including the Osirak or Tammuz reactor, and in Libya and various other countries; for the reprocessing facility in India and in Japan; for fast critical assemblies with large plutonium or highly enriched uranium inventories in Germany, Japan, Switzerland; and for plutonium and highly enriched uranium fuel manufacturing plants in Belgium, Japan, Germany, Canada, and Argentina, and a variety of other facilities as well.

Second: During my service, I represented the Agency's Secretariat in all meetings with its Standing Advisory Group on Safeguards Implementation [SAGSI]. That group is the senior advisory body for safeguards, advising the Director General on matters related to technical criteria and various generic issues associated with safeguards implementation. I was responsible for preparing most of the policy papers during that period, and argued the Secretariat's views, on occasion with success.

Third: In addition to my duties within the System Studies Section, I was a designated inspector in the Euratom countries and participated in seven inspections during that period. Two of those were physical inventory verification inspections at the ALKEM plutonium fuel fabrication facility; the remaining five were inspections at large power reactors. Participation in these inspections is undertaken by Development staff to provide improved understanding of practical problems routinely encountered by the operations staff.

Looking back over my participation with the IAEA safeguards program, I formed some observations which I would like to share with you.

First: I believe that fundamental improvements have been made in the technical effectiveness of IAEA safeguards in the period since 1977. The requirements are more clearly specified, the equipment more efficient and more reliable, staff levels have increased some fourfold, and the staff is far more professionally trained than in the past.

Second: In efforts to improve safeguards effectiveness, the United States has always been in the forefront. While I strongly encourage the continuation of these efforts, I am certain that members of the IAEA Secretariat would welcome probing inquiries and demands for improvements coming from other lands. It is not that we are alone in our concerns as Americans, but all too often the interactions with other countries are limited to diplomatic platitudes without action, particularly in terms of meeting the obligations defined in the respective safeguards agreements.

Third: I am of the opinion that IAEA safeguards work. I am not aware of any undetected diversions of nuclear material, at least during the period from 1977 to mid-1981. The safeguards system seems to provide a set of norms for national behavior, and on the whole, countries wish to work within those norms.

I believe that the wider the system becomes, the tighter the bonds become and the chances for continued success improve. I might say the problems of nonproliferation seem principally to be the materials and facilities which are not under safeguards rather than those subject to IAEA safeguards.

Fourth: It has always struck me that the Agency was very conscientious in maintaining a balance. On the one hand, it must satisfy its member States that the conclusions and assurances it provides are credible, especially when it reports that no diversions have occurred. On the other hand, the system is known to be imperfect: the Agency must keep the support of its sponsors, without unjustified claims, hinting strongly enough at its deficiencies to provide the driving force to improve those flaws. I do not think even one member of the technical staff of the IAEA would consider the existing arrangements satisfactory; most would agree that progress has been made, however, and that further improvements are in the works.

Deficiencies remain in the nature of the Agency's agreements and in the manner in which the countries and the Agency carry out those agreements. Some of those deficiencies may be addressed through legislation; some have to do with the behavior of sovereign States and may be responsive to diplomacy.

I wish to conclude my statement with one final observation. An organization like the IAEA, chartered to care for an important problem, can only succeed if its mission is explicitly defined, if it is provided with the necessary wherewithal and is held accountable for its actions. The most substantive improvements occurring over the past 4 years have resulted from the requirement imposed on the Secretariat by the IAEA Board of Governors that the Secretariat submit an annual Safeguards Implementation Report. This requirement has resulted in a clear definition of the minimum requirements necessary for the safeguards applied at each facility, in standardizing the safeguards for similar facilities between the regional sections, and for providing a clear definition of outstanding problem areas. The IAEA inspectorate is held accountable for their activities to a much greater extent than before.

The Agency has been telling the international community in the safeguards implementation reports that it has serious problems. In 1980, I think the IAEA was only able to provide 42 percent of the inspection effort considered necessary at that point in time. It is the responsibility of the community of nations to support the IAEA and to increase the resources available to the IAEA to the point that is necessary.

I would like to make one final observation before I close: in all the discussions today we seem to have a black-and-white type of perspective, that either safeguards are effective or not effective. It is not at all clear to me how the Nuclear Regulatory Commission can determine on the basis of their evidence that IAEA safeguards are ineffective to the point that they would consider suspension of exports. I think that in all types of facilities there is some possibility for detecting diversion, and that the detection time and sensitivity, the ability to detect diversion would depend upon the quantity of material diverted and on the diversion strategy and concealment scheme that would be used as a method for actually acquiring that material.

There are certainly problems in applying effective safeguards in large facilities and in states with extended nuclear industries, but I think that there is reason to hope; by focusing on inefficiencies in a way that is constructive, further motivations and further improvements will result.

Thank you, Mr. Chairman.

[The following letter was subsequently received for the record:]

INET Corp.,
Sunnyvale, Calif., December 15, 1981.

Hon. Charles H. Percy,
Chairman, Committee on Foreign Relations,
U.S. Senate, Washington, D.C.

Dear Senator: I want to thank you for the opportunity to testify at the Committee Hearings on December 2, 1981, delving into the effectiveness of the non-proliferation safeguards administered by the International Atomic Energy Agency. Many important considerations were brought out, which will be of unquestionable value in efforts to strengthen the existing non-proliferation regime in general, and the IAEA in particular.

It is clear that the current level of IAEA safeguards effectiveness is inadequate to provide the non-proliferation assurances we seek. This appreciation is, in itself, an essential prerequisite to improvement. But recognition within the United States is not enough: that appreciation must be widely shared within the international community before substantial improvements can be brought into effect.

Having established that a problem exists, what might be done to bring about improvements? Some suggestions have already been expressed; of those, some will succeed, some will meet with considerable resistance within the IAEA and within the international community. In the interests of improving the effectiveness of IAEA safeguards, in the following paragraphs I submit a number of additional possibilities, intended to augment the list of those already identified. On the basis of my IAEA service, I believe each would contribute improvements, and each could be accommodated within the existing framework of international agreements.

(1) Questions have arisen regarding whether or not the Osirak (Tummuz) reactors were intended to serve a legitimate peaceful purpose. One possibility to allay future concerns of this nature might be to expand the authorities granted to the IAEA, to make a determination regarding each project initiated within a state, or each international transfer, that the declared uses are consistent with accepted patterns of peaceful nuclear development, appropriate to the state at the time the project is proposed. It would be necessary to reach international agreement on normal patterns of peaceful nuclear development, and to grant the IAEA the authority and responsibility to express its approval or disapproval before any such project is consummated.

(2) If we want the IAEA to improve, to perform a vital mission for us, and we want to use their activities in something as direct as U.S. export licensing, in fairness we must tell the IAEA precisely what we expect, make certain they are given the wherewithal to do what we want, and then, then we must hold them accountable for meeting our needs.

The IAEA is in the process of adopting an evaluation scheme for judging the effectiveness of its safeguards. Using that scheme, minimum performance targets could be identified for each type of nuclear material subject to IAEA safeguards. The IAEA could then plan its programs and measure its progress in terms of meeting those performance targets. Serious consideration should be given to organizing U.S. assistance efforts in relation to that framework.

(3) Within the United States, we have experts able to define the inspection activities which should be adequate for the IAEA to implement effective safeguards. One means to provide assurance that U.S. interests would be served in any export would be to provide the IAEA with a detailed description of the minimum safeguards considered necessary, granting approval for the export only when the IAEA had acknowledged its agreement to implement its safeguards in accordance with that description (or some mutually agreeable alternative). Such a description would include the basic approach to be followed, the equipment to be used, the schedule of inspections to be performed, the inspection activities to be undertaken on each inspection, descriptions of the anomalies which should be detected in the event a diversion occurs, and a list of follow-up actions which should be undertaken in the event anomalies are detected to establish whether or not a diversion is suspected.

(4) Working with other members of the international community, we should help the Agency to be capable of being more effective. Consider the following:

There just aren't enough inspectors.—Listen to what the IAEA is telling us in its annual Safeguards Implementation Reports. For example, they say that they need at least twice the number of inspectors now than they had in 1980 to be able to provide the minimum coverage necessary. Note that the basis they use for reference is not agreed as the minimum necessary; rather, reference is with respect to the numbers negotiated in facility attachments, some old, some new. The actual figures are likely to be considerably higher.

A lot of facility attachments are out of date.—The Agency should review all of its facility attachments to ensure that the provisions allow the Agency the opportunity to satisfy their own criteria. This activity would not require a very great effort and would at least assure that safeguards are being applied on an equivalent basis.

Improve personnel selection.—The Agency is currently not able to interview candidates before selection, and can't get rid of its duds before the contracts expire. Improvements could be brought into effect by more active recruiting (e.g., direct mailing to all nuclear establishments, plus expanded advertising in appropriate journals), pre-employment screening. . . . Within the United States, we might take more of a lead to prepare candidates for IAEA employment, especially those from developing countries, having them take intensive training at Los Alamos and Sandia laboratories, for example.

Improve inspector support.—There isn't enough help within the Agency, and many times it does not appear to be well directed. This is especially true in the support given by the information treatment division. The emphasis must shift to supporting the inspectorate with applications programs and an adequate number of data processing specialists to help make important information available, to make the information system slave to the inspectorate, rather than vice-versa.

Inspectors shouldn't go out alone. Ever!—Even inspections at simple facilities should be undertaken by a team, minimum size: 2! Inspectors face a crowd of people from the facility and from the national authority. They are subjected to scrutiny, questions, the hardships of extensive travel often under trying conditions. I believe that the current policy is an unwise economy which can only lead to poor morale and ineffectiveness.

Build inspection teams to cover the required tasks.—Some progress has been made in this direction, but more should be done. The lead inspector must be technically competent and well trained in matters related to diversion, verification, and the rights and authorities of the Agency and of the state. The inspection team should be made up of junior inspectors and nonprofessional inspection assistants trained in making measurements, applying seals, auditing accounts, etc., performing these needed tasks under supervision while relieving the lead inspector to marshal the information necessary to derive the conclusions required, and to investigate anomalies, preferably as they are identified.

Improve inspection quality assurance.—Further efforts are needed by the IAEA to improve the manner in which inspections are planned and conducted. One means to improve planning would be to help the Agency formalize its inspection planning, briefing and de-briefing, perhaps using the procedures adopted in the Agency's Euratom Section as a model. As a means to improve the quality of inspections, the Agency should create a team (or teams) of senior inspectors to accompany regular inspection teams to determine the adequacy of the safeguards approach and critique the inspections. Such a group should be coordinated through the Safeguards Evaluation Section.

Establish an anomaly review group.—At present, anomalies are defined somewhat differently in the six regional sections, and the follow-up actions undertaken are not standardized and not controlled. An effort should be made to reach a common definition on just what constitutes an anomaly, and what actions should be taken to determine whether or not a diversion may be indicated. The anomaly review group should be given sufficient authority to recommend special inspections where appropriate, and to suggest (order?) facility operators to take the actions necessary to bring about the prompt, unambiguous resolution of outstanding anomalies, once identified.

Get the Agency to report more.—For example, the Agency could report the details of the anomalies it detects (currently on the order of 200 per year), especially those that remain unresolved. They needn't be keyed to specific facilities or states, and thus this information could be provided under existing disclosure arrangements. Perhaps the Secretariat should make a report at each and every Board meeting, describing the unresolved anomalies and the means used to resolve those which had been attributed to innocent causes.

Improve reporting timeliness.—The current reporting scheme requires delays (e.g., transactions are reported by month, a month after they occur—at best), and is hopelessly cumbersome. Commission a study to recommend adoption of reporting based upon telecommunications links, expanding on the "recover" project work.

Provide guidance to States on the basics of nuclear material accounting and control.—Agency inspectors are presented with a mind-boggling mishmash, which they must struggle to understand. Generally this isn't the result of any mischievousness, rather, no guidance is available and entropy triumphs. The IAEA issues a extensive series of safety guides suggesting how states should regulate siting, construction, operation, . . ., features pertaining to nuclear facilities—some efforts are certainly needed in records keeping, inventory taking, error estimation, . . . to improve the basis on which safeguards are built.

(5) For effective IAEA sateguards, the United States must continue to support the IAEA directly and continue the Program of Technical Assistance to the IAEA. Without the former, there is no IAEA; without the latter, there is no hope for improvement.

(6) More concern must be given to the human factors aspects of IAEA safeguards, especially to attitude formation, vigilance and motivation. Some of the items noted above might help in this regard, and one other possibility comes to mind. Just as a football team is more likely to win when the crowds are cheering, we should expect the IAEA staff to be responsive to the support and encouragement of its member states. Further effectiveness could be gained through simple steps intended to reinforce the sense of importance, the concern and support felt within the community. For example, why not gather the entire safeguards staff together in a big room with the Agency's Board of Governors, and have them express in person their support. Of all the recommendations above, I suspect this one would be most cost-effective. Challenge the staff to improve, and provide the climate where improvements are eagerly sought and rewarded. That will help.

The United States is at the forefront of virtually all improvements in the effectiveness of IAEA safeguards. We can do more, especially in the sense of demonstrating how things should be. The application of IAEA safeguards in the United States, especially at the Exxon fuel manufacturing plant in Richland, Washington, is an example of the best kind of leadership we can provide. Under the current terms of the U.S./IAEA safeguards agreements, the IAEA will shift its safeguards to another facility in another year, and the IAEA will no longer be able to derive the full and very positive benefits of this effort. Some arrangement should be created to continue this arrangement as a base for advanced training and demonstration.

Also, we could extend our activities in demonstrating how things should be. The Allied General Nuclear Services Company, operators of the Barnwell Nuclear Fuels Processing Plant have proposed an extended test of the implementation of international safeguards at their reprocessing facility. The tests would not (in the first year) include actual use of spent fuel and no plutonium would be processed, but even with these limitations, that facility represents the state-of-the-art in reprocessing safeguards technology, and the proposed experiments would contribute to further improvements. Serious consideration should be given to funding that experiment, with the active participation of the IAEA and open to all interested nations of the world.

If the human species is to survive, international accommodations must one day evolve which will allow life free of international conflict. Existing nuclear arsenals may then be allowed to deteriorate into disuse, without replacement. We must hold the world together until that time, for as many decades or centuries as it takes.

The Treaty for the Non-Proliferation of Nuclear Weapons, and the safeguards applied by the International Atomic Energy Agency are vital to preventing the spread of nuclear weapons. Every effort must be made to gain acceptance of the NPT by all nations, and to strengthen the bonds that unite the NPT community. There are very few holdouts—each should be examined to identify the steps needed to gain that country's acceptance. We should be prepared to offer incentives, pressures, security alliances; we should, if need be, be prepared to acknowledge the nuclear weapons capability of nations which are not currently enshrined in the NPT as "weapons states."

As new goals and priorities are established for the IAEA, the following points should be recalled: No case has ever been shown where IAEA safeguards have failed—where a nation has developed nuclear weapons under the ruse of false participation in IAEA safeguards, or by escaping detection; view this unique undertaking in concert with the intrinsic value of international verification, with diplomatic initiatives to reduce incentives for proliferation, and bearing in mind that perfection can never be achieved, define these new goals to give measurable improvements.

With every wish for success in this effort, and all due respect,

THOMAS E. SHEA, Ph. D., *Vice President.*

STATE DEPARTMENT'S COMMENT ON THE NRC LETTER TO CONGRESS

The NRC has not informed us of their specific reasons for the concerns expressed in their letter. We do not believe there have been recent events which should trigger a substantial change in our export policies.

The NRC statement oversimplifies a complex subject, and may therefore be misleading. The IAEA applies safeguards so as to maximize the probability, or chance, that, should an attempt be made to divert nuclear material at a facility, that attempt would be detected. There is a specific provision for prioritizing effort on those diversion possibilities involving the most sensitive material. There cannot be an absolute certainty that all diversions paths are covered for example some may be identified after the time the safeguards approach to a given facility is developed, and some may be prohibitively expensive for a divertor. These facts are taken into account when designing the approach. As problems arise, such as in the case of some on-load refueled reactors, the IAEA takes steps to solve those problems. The application of safeguards is a continuously evolving process. We believe that, at the present time, the IAEA has at its disposal all the techniques and instruments necessary to detect, in most cases with sufficiently high probability to result in deterrence of the diversion of nuclear materials. In those cases where the detection probability is not as high as we would like efforts are underway to make the necessary improvements.

The United States continues to regard the international safeguards system of the IAEA as performing an essential role in our effort to prevent the further spread of nuclear weapons.

At the same time, the United States has been engaged in extensive efforts to improve the technical, legal and conceptual aspects of the safeguards regime to keep it abreast of changing conditions and technology. Important progress has been made and these efforts are continuing.

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NUCLEAR NONPROLIFERATION POLICY

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY, NUCLEAR PROLIFERATION, AND
GOVERNMENT PROCESSES

OF THE

COMMITTEE ON
GOVERNMENTAL AFFAIRS
UNITED STATES SENATE

NINETY-SEVENTH CONGRESS

FIRST SESSION

JUNE 24, 1981

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OPENING STATEMENT OF SENATOR GLENN

Senator GLENN. Mr. Chairman, it seems as if every year the world takes a step closer toward nuclear disaster. For years the American public and that of other countries of the world were lulled to sleep by the notion that there was a clear, clean cleavage between nuclear technology for peaceful purposes and nuclear technology for weapons. The public was told that there was no need to be concerned about international transfers of nuclear equipment, materials, and technology because they would be protected by safeguards, and in many cases because the recipient country had provided assurances that it would not make nuclear weapons by virtue of its having signed the Non-Proliferation Treaty.

Now, I certainly am in favor of the Non-Proliferation Treaty. And I also am in favor of effective international safeguards, which neither are all that safe nor all that guarded even. But the world has been mesmerized too long with the notion that ritualized inspections and governmental assurances provide an adequate framework within which unbridled nuclear trade can flourish.

Only in recent years has the public begun to understand that safeguards are designed to detect diversion, not to prevent it—that regardless of the noble statements in the IAEA charter, and other official documents describing the theory of safeguards, the reality is that the safeguards system is falling short of its own goals.

Last year, for example, not only did the agency not carry out the number of inspections that were called for in all its agreements, but there were literally dozens of facilities around the world that received no inspection whatsoever, including in some cases, research reactors operating on high-enriched uranium. Although the agency had approximately 120 inspectors at the end of last year, it's defined inspection objectives would have required more like 180 inspectors. The agency is doing what it can with the resources available to it but it isn't enough. In 1982 the assessed safeguards budget will only be $25 million. That is approximately equivalent to 1/100 of a mil per kilowatt hour of nuclear generated electricity that year.

I might add, one of the first amendments I ever had on the floor of the U.S. Senate when I came here 6½ years ago was to get an extra $1 million for IAEA because they were going to have to let some of their inspectors go unless we had that additional funding for them at that time.

But even if the safeguard system were all that it is supposed to be, it is still only a system of materials accounting—not equipment, just materials—and surveillance.

Inspectors do not have the right to inspect facilities which have not been declared as containing safeguarded materials. Inspectors can be denied the right of entry to a country by virtue of their nationality. Inspection reports are available only to the directorate and to the country being inspected. And even if a piece of intelligence information became available to the agency that some suspicious clandestine nuclear activity might be going on at a particular place, the agency does not have the right to send an inspector to verify the report.

* * * *

June 24, 1981

WRITTEN STATEMENT OF S. JACOB SCHERR ON BEHALF OF THE NATURAL RESOURCES DEFENSE COUNCIL SUBMITTED TO THE SENATE GOVERNMENTAL AFFAIRS COMMITTEE, SUBCOMMITTEE ON ENERGY, NUCLEAR PROLIFERATION, AND GOVERNMENT PROCESSES, CONCERNING U.S. NUCLEAR NON-PROLIFERATION POLICY

I am S. Jacob Scherr, an attorney with the Natural Resources Defense Council (NRDC), a public interest environmental protection organization with some 35,000 members in the United States and abroad. Since 1971, NRDC has been actively concerned about the hazards of nuclear power associated with the presence of nuclear-weapons-usable materials in the civilian fuel cycle. Beginning in 1974, we have focussed upon the problem of American nuclear exports and nuclear weapons proliferation. NRDC has submitted testimony to Congressional committees on several occasions, intervened in a number of Nuclear Regulatory Commission proceedings, and undertaken litigation in support of a strong, effective U.S. nuclear non-proliferation policy. I am very pleased to have this opportunity today to present our views on this matter to the Subcommittee.

The recent Israeli raid destroying a nuclear research reactor in Iraq brought the problem of nuclear weapons proliferation much closer to home for many Americans. For the first time, proliferation was no longer merely an abstration or a distant event of little consequence for our nation. A close American ally in a very volatile part of the world had used American-supplied weapons to destroy a nuclear reactor in another country. This was a drastic action taken by Israel against the perceived threat of Iraqi acquisition of the atomic bomb. We must face up to the fact that the existing system of bilateral and multilateral controls is too weak, too ambiguous to provide assurances to the U.S. and neighboring nations that non-weapons countries are not directing their "peaceful" nuclear programs to the future production of atomic weapons.

Inadequacies of IAEA Safeguards

The Senate Foreign Affairs Committee last week heard testimony from Mr. Robert Richter, an International Atomic Energy Agency (IAEA) inspector, detailing the severe limitations and inadequacies of the existing international safeguards system. The deficiencies of IAEA oversight of "peaceful" nuclear activities are not limited to Iraq nor are the concerns expressed by Mr. Richter new. In 1975, the U.S. General Accounting Office (GAO) issued a study entitled "Assessment of U.S. and International Controls Over the Peaceful Uses of Nuclear Energy."* The GAO found that:

-- IAEA inspectors do not have unlimited access on their safeguards inspections, nor do they have the authority to seek out undeclared or clandestine nuclear facilities or stockpiles.

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* GAO Report No. 10-76-60 (September 14, 1976).

-- IAEA inspectors must be accredited by the nation in which they are to inspect and that nation has the right to reject any inspector. This accreditation process has been used by some countries to hamper safeguards implementation.

-- Inspectors face difficulties in carrying out verifications of nuclear material inventories because of differences in facility, national, and international systems; slowness in reporting the receipt or export of nuclear materials; and the inaccuracy or incompleteness of material accountancy records.

-- Inspectors do not have the technical equipment and procedures to carry out effective physical measures of nuclear material inventories.

-- Some inspectors lack practical experience and sufficient training. Recruitment of a skilled inspection staff is hampered by low salaries and geographic distribution requirements.

-- The IAEA is facing problems in securing sufficient funding to match its increased safeguards responsibilities.

-- IAEA safeguards agreements with non-NPT countries preclude the use of safeguarded material and equipment for "furthering any military purposes", but some countries interpret this phrase as permitting the development of "peaceful" nuclear explosives.

-- Even if the IAEA detected and disclosed a diversion in violation of a safeguards agreement, the prescribed sanctions are very limited and perhaps meaningless. The IAEA can only order a recall of IAEA-sponsored material and technical assistance and suspend membership rights.

At the time, the IAEA had just 40 inspectors to safeguard 400 facilities around the world. The GAO stated its belief that "the United States may be relying on international safeguards which were not being adequately carried out."

The response of the United States to the GAO report and growing doubts about the effectiveness of IAEA safeguards was to increase American financial and technical support to the agency. In May 1981, the GAO reported that while efforts had been made to address some of the safeguard deficiencies noted in its 1976 study,

> "the magnitude of IAEA safeguards responsibilities have outpaced these efforts and the IAEA continues to encounter the same basic problems"*

In 1980, the IAEA had about 100 fully trained inspectors. However, the number of facilities covered by safeguards had grown to 715 and is expected to increase to 779 by 1983. The IAEA system must be strengthened, not just by increasing manpower or the sophistication of technical safeguards devices. The United States should take the initiative in seeking a full reexamination of the IAEA system.

Need For NRC To Assure Adequacy of IAEA Safeguards Implementation

A major problem regarding the IAEA remains the excessive secrecy surrounding its safeguards activities. In 1975, the

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* "The Nuclear Non-Proliferation Act of 1978 Should be Selectively Modified", GAO Report No. OCG-81-2, at 47 (May 21, 1981).

GAO stated that the U.S. does not have enough information to evaluate IAEA safeguards effectiveness. In 1977, following the issuance of the IAEA's first Safeguards Implementation Report (SIR), the NRC's Office of Nuclear Material Safeguards and Security refused to continue to certify the adequacy of IAEA safguards covering nuclear materials and equipment proposed to be licensed for export.* While the NRC has pressured the State Department for more country-specific information about IAEA safeguards implementation, the NRC continues to rely primarily on blind faith in the IAEA system.

Pursuant to the Nuclear Non-Proliferation Act of 1978 (NNPA) the NRC must determine that a proposed nuclear export meets the criteria set out in Section 127. Criterion 1 states that:

> IAEA safeguards as required by Article III(2) of the [Nuclear Non-Proliferation] Treaty will be applied with respect to any such material or facilities proposed to be exported to any such material or facilities previously exported and subject to the applicable agreement for cooperation, and to any special nuclear material used in or produced through the use thereof.

The precise issue of whether the NNPA requires the NRC to make an independent assessment of the adequacy of those safeguards was addressed during Senator floor consideration of the Section 126(a)(2) of the NNPA. Introduced as an amendment to S. 897 by Senator McClure, this section provides that the Commission is neither required to conduct nor prohibited from conducting country or site specific visitations in its consideration of the application of IAEA safeguards. The amendment was accepted only after agreement between Senators McClure, Glenn and Percy that the Commission is required to independently assess the adequacy of IAEA safeguards. Summarizing the discussion of the amendment, Senator Percy said:

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* See "NRC, Safety Experts Split on International Safeguards", Washington Post, January 17, 1978, at A12. This and subsequent SIRs have been classified.

> "It is not really a question of whether the NRC independently will assess the adequacy of safeguards. The question is really how they will do it."*

As noted in the recent GAO report on the NNPA, the NRC Commissioners have failed to resolve this question. It is our view that the time has long past where mere assertions and fragmentary information as to the effectiveness of IAEA safeguards will suffice. We believe that the NRC must be in a position to assure the Congress and the American public that IAEA safeguards are being implemented adequately as to U.S. nuclear exports. We agree with the GAO that the NRC's responsibility in this regard must be clarified. It is our view, given the urgency of the proliferation problem, that the

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* Congressional Record, February 7, 1978, at S. 1464.

NRC should suspend licensing of nuclear exports until it is provided with enough data to make a reasoned judgement as to the adequacy or inadequacy of IAEA safeguards.

(Excerpt)

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

The Nuclear Non-Proliferation Act Of 1978 Should Be Selectively Modified

The short-term impact of the Nuclear Non-Proliferation Act of 1978 in establishing an effective international framework for controlling the proliferation of nuclear explosive capabilities has been limited. However, it represents a long-term agenda requiring ambitious international initiatives which often take a long time to conclude. Although GAO does not believe that major changes should be made, it believes the Act should be selectively modified to

--conform with political, technical, and economic realities,

--obtain wider international acceptance,

--preserve the framework for curbing the inherent risks of weapons proliferation associated with peaceful nuclear cooperation, and

--improve executive branch implementation.

This report fulfills GAO's reporting mandate contained in the 1978 Act.

UNITED STATES GENERAL ACCOUNTING OFFICE

OCG-81-2
MAY 21, 1981

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-202299

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses our assessment of the Nuclear Non-Proliferation Act of 1978. It includes our suggestions for revising some aspects of the Act and contains recommendations to the involved agencies for improving their implementation of the law.

Our review was made pursuant to section 602(e) of the Nuclear Non-Proliferation Act of 1978 which requires that the Comptroller General complete a study and report to the Congress, 3 years after enactment, on the implementation and impact of the Act. Moreover, the Act requires that this report contain such recommendations as the Comptroller General deems necessary to support the law's policies, purposes, and objectives.

We are sending copies of the report to the Director, Office of Management and Budget; the Secretaries of State and Energy; the Director, Arms Control and Disarmament Agency; the Chairman of the Nuclear Regulatory Commission; and the Administrator of the Agency for International Development.

Acting Comptroller General
of the United States

CHAPTER 4

NO CHANGES NEEDED IN TITLE II, BUT INTERNATIONAL SAFEGUARDS NEED IMPROVEMENTS

Title II reaffirms U.S. support to strengthen IAEA safeguards. Specifically it calls for the United States to contribute financial, technical, informational, and other resources to assist IAEA in effectively implementing safeguards. An intensified U.S. effort to upgrade IAEA safeguards, which actually began as a 1976 presidential pledge, has had some positive results, but U.S. officials concede that the program has not yet had as significant an impact on actual safeguards in the field as had been hoped.

Title II also calls on the United States to work with other nations to establish (1) international procedures to be followed in the event of diversion, theft, or sabotage of materials or equipment, and to recover any nuclear material stolen, lost, or diverted, and (2) general principles and procedures to be followed if a nation violates an obligation regarding the peaceful use of nuclear material, equipment, or technology. In addition, the NNPA states that U.S. policy is to strongly encourage adherence to the NPT.

Some progress has been made in the physical protection of nuclear material and increased NPT adherence. However, there seems to be little interest abroad in developing specific international sanctions.

In our opinion, Title II represents a strong commitment to IAEA and U.S. non-proliferation efforts, and no change seems necessary. However, international nuclear safeguards need improvements.

IAEA SAFEGUARDS AND U.S. INTEREST IN THEM

IAEA safeguards are a cornerstone of the international nuclear non-proliferation efforts and are important to U.S. non-proliferation objectives. The United States relies on the international safeguards system to sound the alarm if nuclear material is diverted. Moreover, it has helped persuade other nations to rely on IAEA safeguards for assurance that others are not developing nuclear explosive devices.

Since IAEA was established, substantial U.S. support has been provided to the IAEA safeguards program. The United States has encouraged IAEA safeguards coverage on all peaceful nuclear activities within a nation--often referred to as full-scope safeguards. The United States also supports adherence to the NPT and the Treaty of Tlatelolco, which require non-nuclear weapon nations to accept full-scope safeguards.

The NNPA makes acceptance of IAEA safeguards on all existing peaceful nuclear activities a condition of U.S. supply under new or revised agreements for cooperation, and for exports under existing agreements. In addition, the United States has tried to extend the application of IAEA safeguards through the Nuclear Suppliers Group and the U.S.-IAEA agreement to place U.S. facilities under international safeguards.

International safeguards are intended to detect, in a timely manner, diversions of significant quantities of nuclear material from peaceful nuclear activities, and to deter such diversions by the risk of early detection. To accomplish this, IAEA depends upon material accountability and containment and surveillance devices.

In recent years, there has been a great increase in the number of facilities subject to safeguards. [1] IAEA is now responsible for the application of safeguards at new types and sizes of facilities of important concern from a non-proliferation standpoint. In addition, IAEA is now responsible for safeguarding complete nuclear fuel cycles within a nation or close group of nations.

RESULTS OF INTENSIFIED U.S. EFFORT TO UPGRADE IAEA SAFEGUARDS

To help IAEA upgrade its safeguards system, President Ford, in 1976, pledged $1 million of special help annually for 5 years.

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[1] Today, the vast majority of nuclear facilities and material in non-nuclear weapons nations is subject to IAEA safeguards. However, five nations are operating at least one unsafeguarded facility: India, Israel, South Africa, Egypt, and Spain (although the two latter nations have recently agreed in principle to accept safeguards on all of their nuclear facilities). In addition, Pakistan is currently developing reprocessing and enrichment facilities which apparently will not be subject to IAEA safeguards. Of the nuclear weapon nations, the United Kingdom, France, and the United States have agreed to place their nuclear facilities--except those of direct national security significance--under IAEA safeguards. The two other nuclear nations--People's Republic of China and the Soviet Union--do not have their facilities under IAEA safeguards.

As a result, DOE, State, ACDA, and NRC initiated a program of coordinated actions to upgrade and support IAEA safeguards, including the Program of Technical Assistance to Safeguards (POTAS).

For many years, DOE, ACDA, and NRC have had individual agency programs designed to support international safeguards. The roles and responsibilities of these agencies cover a broad range of interrelated safeguards activities such as policy, planning, technical consultation, equipment, and training to increase the effectiveness of IAEA safeguards. Nevertheless, U.S. officials have stressed that POTAS has become the main vehicle for providing technical resources, funds, and other support to upgrade IAEA safeguards as envisioned by the NNPA.

The United States has provided almost $19 million through POTAS to upgrade IAEA safeguards from fiscal year 1976 through fiscal year 1980, and about $4 million is planned for fiscal year 1981. This was to be a short-term program, intended to provide quick reaction to urgent needs identified by IAEA to improve safeguards where normal IAEA budget channels could not respond. Technical assistance provided under POTAS was meant to complement IAEA's normal procedures for fulfilling its safeguards needs.

All POTAS tasks are carried out in response to requests by the IAEA Director General. After a task is approved and funded by the United States, the U.S. contractor is to prepare a detailed work plan for review and approval by IAEA staff responsible for oversight of the task. These procedures are intended to ensure that tasks are responsive to IAEA needs.

As of December 1980, POTAS had completed 190 of the 270 tasks undertaken. These tasks have been directed at providing (1) upgraded measurement techniques, (2) training for inspectors, (3) system studies to improve safeguards techniques for existing and future nuclear facilities, (4) support to information processing systems and field operations, and (5) improved containment and surveillance techniques.

Positive results

The most noteworthy accomplishments have been improved inspector training and better information processing systems. Technical experts, who supplement IAEA's staff, also have provided valuable assistance in equipment technology and the development of systems studies designed to improve safeguards techniques. IAEA's ability to verify some nuclear materials quantitatively was improved by the development of safeguards instruments.

Many urgent needs not met

Despite the progress made, many of the urgent needs identified by IAEA have not yet been met. For example, most of the equipment resulting from POTAS is still in the development and testing stages and is not being used routinely on inspections. Inspectors complain that the system studies seem to be aimed at longer-term problems and not at solving current ones.

Safeguards equipment must often be developed through an evolutionary process. The POTAS program has utilized the expertise of U.S. laboratories and industrial firms that provide a specialized or unique service where commercially available equipment does not exist. Equipment tasks are, to a large degree, research projects which do not produce equipment for immediate use. According to IAEA personnel, equipment prototypes provided under POTAS often need modifications to make them better suited for use in the field.

At the time of our review, few pieces of equipment provided by POTAS were being routinely used, even though a considerable amount had already been spent on equipment development. As of June 1980, POTAS had provided approximately $1.7 million in equipment to IAEA, but about $3.1 million had been spent on equipment development tasks under POTAS.

Systems studies analyze problems to provide alternatives for improved safeguards procedures and operations. About 45 system studies have been undertaken. However, such studies may not focus on problems of immediate concern to IAEA. Some IAEA officials believe a number of system study tasks have failed because (1) they have not provided timely or practical solutions to current problems, (2) the studies have been too broad in scope, or (3) they use national and not international safeguards concepts. Overall, some IAEA officials believe that, although systems studies are important because they provide an alternative approach to some problems encountered in safeguard implementation, a number have no immediate impact.

IAEA experiencing problems in absorbing results of POTAS

It appears that IAEA does not have the ability to absorb the results of some projects. IAEA has experienced difficulty in getting the results to the inspectors for use in the field. In particular, IAEA has lacked adequate financial and personnel resources to use the products from all the tasks requested.

DOE officials advise us that up to 19 cost-free experts have been provided at any one time and these experts, working under contracts with IAEA, supplement IAEA resources in bringing the products of POTAS into use. Moreover, a new POTAS project was approved in 1980 to help get the results of some projects beyond the IAEA testing stage and into operational use. This project provides funds for IAEA and U.S. contractors to perform field tests and evaluations at facilities outside the United States.

IAEA is experiencing problems with inadequate financial and personnel resources, and these problems may be intensified as it is called upon to use more sophisticated equipment and procedures. U.S. officials also have stated that IAEA may not be able to afford to buy items developed under POTAS in the needed quantities. As an example, they cite the need for 40 TV surveillance units which cost $50,000 each.

IAEA more dependent on U.S. support

POTAS was established to provide, for a limited time, resources to IAEA when its own resources were inadequate. However, the increased U.S. support has made IAEA much more dependent on continued U.S. support.

IAEA relies heavily on the U.S. program to support its safeguards effort. The growing IAEA dependence on the United States can be readily seen in the supply of equipment. Under the POTAS program, new techniques and prototype equipment are being developed and tested. Now IAEA looks to the United States for assistance in implementing these new developments. This means providing pieces of equipment for routine use in the field. If sophisticated safeguards equipment is provided and adequate IAEA financial resources are not set aside for replacement and maintenance costs, then IAEA dependence on U.S. support may increase further.

DOE officials advised us that one U.S. expert is currently working with IAEA to help plan equipment budgets for future years.

IMPROVEMENTS NEEDED IN IAEA SAFEGUARDS

Substantial improvements are required if IAEA is to fulfill its increasing safeguards responsibilities. The number of facilities and the amount of nuclear material under safeguards has increased rapidly in recent years. Many of the nuclear facilities now subject to safeguards are larger and more complex than those originally under safeguards. To meet its responsibilities, IAEA needs more technical, political, and financial support from its members.

The extent to which present safeguards are effective is largely a matter of judgment. It would be difficult to prov if or to what degree safeguards have achieved their desired effect. Nevertheless, it is clear that the credibility of international safeguards as a deterrent to proliferation depends upon the probability of prompt detection. In many cases this probability of detection needs to be increased.

IAEA has not detected any discrepancy which would indicate the diversion of a significant amount of safeguarded nuclear material, and it concludes that all such material remains in peaceful nuclear activities or is otherwise adequately accounted for. However, the degree of confidence that can be associated with current IAEA safeguards depends on such things as the amount, scope, and nature of the inspection effort.

International safeguards have reached different degrees of development for different types of facilities; in part, because IAEA experience in safeguarding certain types is considerably greater than for others. For example, IAEA has experience in safeguarding thermal power reactors (particularly light water reactors), but limited experience in safeguarding fast breeder reactors. Also IAEA has experience in safeguarding certain bulk handling facilities--conversion and fabrication plants--but limited experience in applying safeguards to reprocessing and enrichment plants.

Several factors hinder IAEA in applying safeguards including, (1) a limited number of inspectors, (2) a lack of suitable techniques and equipment, (3) inadequate nuclear material accounting practices by some nations, and (4) political constraints. Moreover, IAEA is experiencing financial constraints in performing its increasing safeguards responsibilities. It seems reasonable to conclude that IAEA's safeguards effectiveness has been adversely influenced by these problems. 1/

--IAEA has an obligation under its safeguards agreements to conduct inspections. To fulfill its safeguards responsibilities, IAEA must have the necessary manpower to inspect, verify, and insure that a diversion of peaceful nuclear material has not taken place. However, the number of IAEA inspectors has not kept pace with its rapidly growing safeguards responsibilities.

--The lack of suitable safeguards equipment is a primary reason why quantitative verifications

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1/The impact of these problems is discussed in our classified report entitled "International Nuclear Safeguards Need Further Improvement" (C-ID-81-4, February 13, 1981).

in many cases cannot be adequately made. [1] A substantial amount of material is in a form that is currently unmeasurable. While improvements have been made in recent years in the equipment to verify nuclear materials quantitatively, U.S. officials recently concluded that more reliable and suitable measurement equipment was needed by inspectors. In addition, containment and surveillance systems are not reliable for assuring the integrity of material control and accountability systems.

--A nation is obligated to provide IAEA with accounting records and reports for all its nuclear material subject to safeguards. IAEA officials have repeatedly indicated a need for some nations to improve the quality of the nuclear material accountability information. To help alleviate these difficulties, the United States, in line with Title II of the NNPA, has provided training to officials of other nations in implementing national systems for the accounting and control of nuclear material.

--Effective safeguards depend in large measure on the intent and cooperation of the host nation. In some cases, IAEA has had some difficulty in obtaining such cooperation. An example of this is the conditions established by some nations in consenting to the designation of inspectors. While it is the right of every nation to accept or reject a proposed inspector, there is the serious and growing practice of rejecting whole categories of proposed inspectors on political, linguistic, or nationalistic grounds. According to IAEA's Director General, this practice has unfortunately led to retaliatory discrimination, distortions of the recruiting pattern, and effective deployment of inspectors in the field.

--The IAEA Statute provides that the cost of safeguards is to be apportioned among all member nations. The reason for this was that the imposition of international controls is in the interest of the world community. However, with the advent of the NPT, many members, particularly developing nations, were concerned that expected increases in safeguards expenses would have the effect of increasing assessed contributions and/or diminishing other IAEA programs. Because of mounting costs of safeguards

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[1] See our report entitled "Nuclear Fuel Reprocessing and the Problems of Safeguarding Against the Spread of Nuclear Weapons" (EMD-80-38, March 18, 1980).

> and the controversy as to how these costs were to be met, a complex formula was developed in 1971. Since then, more than two-thirds of the member nations have been insulated from an increased financial responsibility for implementing new safeguards. (See app. V.) Many member nations maintain that the financial resources of IAEA should be used primarily for technical assistance to less developed nations and to promote peaceful uses of nuclear energy. Thus, while many nations, in theory, fully support international safeguards, many are less supportive financially. The United States, in line with Title II of the NNPA, has encouraged other member nations to render special assistance to IAEA in the technical aspects of safeguards. Several are now providing technical assistance to IAEA. These special assistance programs of member nations represent a commitment to improving safeguards, and further efforts should be encouraged. Nevertheless, such programs should not lead to the dilution of the basic premise that the cost of IAEA safeguards are to be apportioned among all member nations.

In July 1975, we reported that political, financial, technical, and material accountability problems were being encountered in applying international safeguards. 1/ Since that time, efforts have been made to address some of these issues, but the magnitude of IAEA's safeguards responsibilities has outpaced these efforts and IAEA continues to encounter the same basic problems.

LACK OF CONSENSUS ON COMMON INTERNATIONAL SANCTIONS

Title II calls on the United States to seek to negotiate with other nations and groups of nations to adopt general principles and procedures, including common international sanctions to be followed in the event that a nation violates (1) any material obligation regarding the peaceful use of nuclear materials and equipment or technology, or (2) the principles of the NPT, including detonation of a nuclear device by a non-nuclear weapon nation.

While the NNPA was being formulated, U.S. officials attempted to negotiate procedures for common sanctions. Since discussions were underway with the Nuclear Suppliers Group, the executive

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1/See our report entitled "Role of the International Atomic Energy Agency in Safeguarding Nuclear Material" (ID-75-65, July 3, 1975).

branch used the opportunity to discuss sanctions as called for in the NNPA. The Group's final document, published in February 1978, states:

> "In the event one or more suppliers believe there has been a violation of supplier/recipient understanding. . . particularly in the case of an explosion of a nuclear device, or illegal termination or violation of IAEA safeguards by a recipient, suppliers should consult promptly through diplomatic channels in order to determine and assess the reality and extent of the alleged violation." (Paragraph 14, subparagraph (c)).

Most nations were generally not willing to agree to abstract sanctions because it required a commitment to take a specific, and presumably serious, action against other governments under circumstances which cannot be adequately defined. Most suppliers indicated that they would rather approach the issue of sanctions by consultation and on a case-by-case basis. The effectiveness of sanctions in terminating nuclear cooperation may or may not be an effective deterrent, but other nations believe that without a certain amount of flexibility the presumptive posture of sanctions could make the cost and risk of taking action too high.

Because U.S. officials apparently found it was difficult to get members of the Nuclear Suppliers Group to agree in abstract to specific sanctions, the State Department has done little more to establish common sanctions since the passage of the NNPA. Nevertheless, State Department officials advised us that they had already sought such common sanctions, and they believed that the NNPA requirements had been satisfied.

Obtaining a broad multinational consensus for future automatic sanctions, to be applied if a nation were to engage in proscribed activities, would require the world community to reach agreement in advance on the following questions. What is a violation? How it would be verified? What sanctions would be appropriate in a given set of circumstances?

Some international sanctions already exist. For example, the IAEA Statute which calls for the suspension or termination of IAEA membership rights and privileges, and the return of any agency-provided nuclear material, equipment and/or device, if IAEA safeguards inspectors detect a diversion of nuclear materials. Title II is an attempt to enhance such sanctions in a negotiated set of guidelines to be followed by the world community. However, the executive branch feels that, at least for the present, the adoption of common sanctions cannot be achieved.

EFFORTS TO IMPROVE PHYSICAL PROTECTION ARE GETTING RESULTS

Title II directs the U.S. Government to negotiate international procedures to be followed in the event of diversion, theft, or sabotage of nuclear materials that have been lost or stolen, or obtained or used by a nation or by any person or group in violation of NPT principles.

Since 1977 the United States has been advocating the negotiation of an international convention on the physical protection of nuclear material. Negotiations for the convention were completed in October 1979. The Convention, which was opened for signature on March 3, 1980, requires nations to take appropriate steps to protect nuclear material used for peaceful purposes during international transport, and not to authorize the import or export of such material unless assured that it will be protected during transport at prescribed levels of physical protection. It also establishes a framework for international cooperation to recover lost or stolen material, and a system for prosecution or extradition for serious offenses.

U.S. officials point out that the Convention successfully completed a United States initiative to establish a regime of international cooperation to improve the physical protection of nuclear material, and that this achievement constitutes a major step in fulfilling the goals expressed in Title II.

In accordance with Title II, the U.S. Government, in cooperation with IAEA, has also been conducting international training courses on the physical protection of nuclear material and equipment at U.S. national laboratories.

REASONABLE APPROACH TO PROMOTE NPT ADHERENCE BUT MIXED RESULTS

One major policy objective of the NNPA is to strongly encourage nations which are not party to the NPT to become parties at the earliest possible date. The United States has taken a reasonable approach in promoting adherence and there has been some progress. U.S. officials believe that the NNPA has been helpful in some respects, but also recognize that a number of NPT parties have criticized the NNPA. These criticisms include allegations that the NNPA is a unilateral effort and adds another layer of controls to those required by the NPT. Some nations have asserted that aspects of the NNPA could in fact weaken or subvert the NPT. In general, it appears that some aspects of the NNPA may have increased tensions within the NPT community regarding peaceful nuclear cooperation.

Through diplomatic initiatives and various incentives, the United States has been encouraging nations to sign the NPT; however, the approaches available to the United States are limited. In fact, the United States is not actively promoting the NPT in some nations because of their strongly negative stance toward the NPT or because U.S. influence is minimal or concentrated on other high-priority interests.

Since the enactment of the NNPA, the United States has approached about 30 nations on the matter of becoming party to the NPT. It has also explored the prospects of approaching several others, but decided that the current diplomatic climate was not conducive to NPT discussions. 1/

The United States avoids assuming a high profile in encouraging NPT adherence because it believes such a profile would be counterproductive and because the NPT is an international, not a national, effort. Several factors are considered in determining whether a particular non-party nation is approached by the United States about NPT adherence, including (1) the actual and potential nuclear capabilities of the nation, (2) the priorities of U.S. interests in the nation and/or region, and (3) the degree of U.S. influence with the nation on this topic.

Nations with little or no nuclear capability or potential are not ignored, as adherence by any additional nations serves to further isolate the non-party nations. However, some key nations with substantial nuclear capability are not currently being approached because of longstanding and continuing opposition to the NPT and/or a lack of U.S. influence. India, Brazil, and Argentina, for example, have taken a strong stance against the NPT. As a result, the United States believes that efforts to persuade them to adhere would be fruitless and therefore is not attempting to do so. In addition, changes in the international political environment can force a reordering of diplomatic objectives and interrupt or postpone NPT promotion efforts.

In addition to its diplomatic efforts, the United States offers incentives which attempt to address the concerns of many non-nuclear weapon nations and encourage NPT adherence. These include but are not limited to

--technical assistance through IAEA to non-nuclear weapon NPT nations,

--the ratification of a U.S.-IAEA agreement to place U.S. peaceful nuclear facilities under IAEA safeguards,

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1/See our report entitled "Evaluation of U.S. Efforts to Promote Nuclear Non-Proliferation Treaty" (ID-80-41, July 31, 1980).

- --indications that NPT adherence will facilitate entering into a nuclear cooperation agreement with the United States,
- --new criteria and procedures for licensing certain exports to nations with good non-proliferation credentials, and
- --lifting ceilings on power reactor fuel supplies where they are specified in U.S. agreements for cooperation with NPT parties.

Since the passage of the NNPA, 12 nations have become party to the NPT. They are Liechtenstein, the Congo Republic, Tuvalu, Sri Lanka, South Yemen, Indonesia, Bangladesh, Cape Verde, Barbados, Turkey, Saint Lucia, and Egypt. These nations bring the number of nations adhering to the NPT to 115.

Among those who have yet to ratify the NPT are the People's Republic of China, Spain, India, Israel, Pakistan, Brazil, Argentina, South Africa, and France. France, however, has indicated that it would act as if it were an NPT party.

In August-September 1980, a conference to review the operations of the NPT was held. In the statements made during the Conference, there was a general reaffirmation of the NPT and its objectives, and many nations called on non-parties to adhere to the NPT. However, the Conference failed to achieve consensus on a final declaration, and U.S. officials believe this could very well impede efforts to encourage other nations to adhere to the NPT.

Although the most divisive issues at the Conference involved arms control, many nations expressed varying degrees of unhappiness about the present state of nuclear cooperation. Of particular concern were post-1975 changes in nuclear export requirements imposed by supplier nations, such as the NNPA and the Nuclear Suppliers Group guidelines. The NNPA was the subject of both explicit and implicit criticism.

Some executive branch officials believe that the NNPA has, in some respects, helped promote adherence but concede that it may have also increased the already existing tensions within the NPT community.

CONCLUSIONS

Title II calls for U.S. efforts to strengthen IAEA safeguards and to negotiate common international sanctions and physical protection measures. It represents a strong commitment to IAEA and non-proliferation efforts in general, and, in our opinion, no change seems necessary.

It seems reasonable to conclude that safeguards effectiveness has been adversely influenced by the problems IAEA has been experiencing. The United States and others have been working to strengthen IAEA safeguards. Despite these efforts, many urgent needs have not yet been met and further improvements are needed. U.S. and IAEA officials believe POTAS is helping to strengthen safeguards and should be continued, but U.S. officials concede that the program has not yet had as significant an impact on safeguards implementation as had been hoped.

Continued support to improve safeguards seems appropriate. The cost of safeguards is low compared to the costs of world insecurity and increased military weaponry. However, care must be exercised so that IAEA does not become too dependent on the United States for its support. To retain its character as an international organization, IAEA must receive technical, political, and financial support from all its members.

Some limited international sanctions already exist. Enhancing such sanctions is worth pursuing as a long-term objective, but U.S. officials found it difficult to get others to agree to further sanctions in abstract terms, and they believe such sanctions are not currently achievable. Nevertheless, there appears to be no need to delete the call for common sanctions from the U.S. strategy. Rather, it should remain as part of the NNPA's long-term goals.

Although 2 to 3 years will probably elapse before enough nations ratify the Convention for Physical Protection of Nuclear Material to bring it into force, we believe it is a positive step in the overall effort to control the use of nuclear materials.

A major policy objective of the NNPA is to strongly encourage nations to become NPT parties, and the United States has been active in this regard. We believe the approach taken by the United States in promoting NPT adherence is reasonable.

RECOMMENDATIONS

We recommend that the Secretary of State meet with other world leaders and IAEA officials to address the problems impeding the effective application of international safeguards and to develop a multinational plan to overcome these problems. Renewed consideration should be given to how international safeguards should be financed, staffed, and provided with the necessary technical support.

We recommend that the Secretary of State, in consultation with the Secretary of Energy, the Director of the Arms Control and Disarmament Agency, and the Nuclear Regulatory Commission, reconsider the direction and scope of POTAS, in light of (1) the original intent of the the program, (2) the provisions of the Nuclear Non-Proliferation Act of 1978, (3) the increasing dependence of IAEA on this U.S. program, and (4) the need to retain the international character of the IAEA safeguards system.

STEVE WEISSMAN AND HERBERT KROSNEY, THE ISLAMIC BOMB

Trying to Halt the Spread

What is to stop the worst from happening? The conventional answer of the community of nations is to rely on the Nuclear Nonproliferation Treaty and the "safeguards" of the International Atomic Energy Agency, a United Nations organization based in Vienna.

That is the Nonproliferation Treaty. The International Atomic Energy Agency and the adequacy of its "safeguards" raise a more complicated set of concerns.

Working under the wing of the United Nations, the IAEA has the responsibility to supervise more than 700 nuclear installations in some fifty countries. This includes all openly admitted nuclear installations in those "non-nuclear weapons states" that have signed and ratified the Nonproliferation Treaty, as well as certain specific facilities in other countries, such as a small U.S.-supplied research reactor in Israel and various power reactors and other installations in India and Pakistan.

In itself, this is an unprecedented and unenviable task. Never before has any international body attempted to involve itself so deeply in the most sensitive area of the economic life of so many nations, each jealous of its own national sovereignty. To make the job even harder, the IAEA has been forced to work within a straightjacket of built-in constraints. It is supposedly the world's top nuclear cop. But it has no police powers. It has no intelligence service of its own. It must depend to a frightening degree on the voluntary cooperation of the various nations it is supposed to monitor, and also on the intensely political decisions of the member nations on its Board of Governors.

Perhaps the biggest difficulty, though, is that the IAEA is expected to play two often conflicting roles. It is supposed to promote the worldwide growth of nuclear power and research programs, chiefly by encouraging the spread of "civilian" nuclear technology and providing technical assistance to nations in the Third World. At the same time, it is supposed to prevent the spread of nuclear weapons.

The conflict is obvious. Yet all too often, IAEA officials deny the difficulty, insisting against the evidence that there is no necessary link between the civilian nuclear technologies that they are promoting and the nuclear weapons that they are trying to prevent.

"It is far easier and cheaper to make a bomb than to launch a nuclear power program," argued the Agency's just-retired number-two man, the highly articulate David Fischer, with whom we spoke. "Historically, the half-dozen nations that have nuclear explosive capacity have acquired it by building a series of specialized plants, dedicated to the production of nuclear explosives. In no case has proliferation resulted from, or even been undertaken under the cloak of a civilian nuclear power program."

Fischer is a persuasive man, a tall, distinguished-looking, and very sophisticated South African, and when we interviewed him at the IAEA's new offices at the "modernistic" United Nations complex in Vienna, we found him forthcoming and one of the few top international civil servants willing and able to break free from the mind-numbing bureaucratese that passes for communication in all parts of the U.N.

But as we discovered during our investigation, Fischer's argument that proliferation has never resulted from civilian nuclear power programs is misleading about the past. The Indians, for one, used a supposedly peaceful nuclear research reactor and reprocessing facilities to produce the plutonium for their "peaceful nuclear explosion," and the celebrated French nuclear deterrent, the *force de frappe*, borrowed heavily from France's initially peaceful efforts in nuclear research and development following World War II. Even worse, Fischer's argument completely avoids what is happening now, especially the budding nuclear arms race in the Middle East.

Both the Iraqis and the Pakistanis are purchasing essentially civilian nuclear technologies to produce nuclear explosives. The Indians have declared that their new reprocessing facility at Tarapur is needed for their civilian nuclear power program, even though they will be able to use the reprocessed plutonium to build a large nuclear arsenal. And all three nations are actually pursuing relatively ambitious peaceful nuclear programs at the very same time as they are pursuing nuclear weapons. In other words, they are going both ways at once. In fact, within the Middle East, it is only the Israelis who have gone straight and single-mindedly for nuclear weapons. Like the Indians, they got the basis of their nuclear option back in the early sixties.

But Fischer's argument is typical. As major promoters of nuclear power, IAEA officials do not like to hear about the dangers of civilian nuclear technology. Their job is not to assess the hidden intentions of nations that have signed the Nonproliferation Treaty, such as Iraq, but only to monitor a country's *declared* facilities and to make technical reports on what they have seen of the country's use of nuclear fuels. In their public pronouncements and private statements, IAEA officials often sound as if they are more concerned to make the world *safe for* nuclear power than *safe from* nuclear weapons. As a result, the Agency seems oddly unprepared to meet the present threat of proliferation, and often irrelevant to any possible solution.

This is even the case in the Agency's main line of defense against proliferation, the so-called nuclear safeguards that are employed to do the monitoring. In practice, the safeguards are a series of measures to keep track of "sensitive" nuclear materials, the processes that produce them, the tanks that store them, and the facilities that handle them. Each nuclear installation under safeguards is expected to keep a record of all such materials and to account for any changes that are produced through nuclear reactions or other processes. The IAEA makes periodic inspections, at times to be agreed on by the Agency and the concerned country, to audit these accounts and to make sure that the material balances are what they are supposed to be.

The inspectors also install and monitor a wide range of technical devices to make sure that nuclear materials cannot be moved or altered without detection. These include tamper-proof locks and seals on materials containers and containment areas and even on parts of reactors, and still and motion-picture cameras and video recorders to watch over sensitive areas and operations. The inspectors also make qualitative checks on nuclear materials, using neutron counters and gamma-ray spectrometers.

The goal of all this prying and poking is simple—to provide "timely detection" of any diversion of a "significant quantity" of bomb-prone materials. The Agency claims there has been no such diversion in the 700-odd facilities it monitors in more than fifty countries. "A significant quantity" of bomb-grade fuel for the IAEA would normally be the amount of any material that would be needed to make a single nuclear explosive device. The Agency presently defines this as a minimum of twenty-five kilograms of highly enriched uranium or eight kilograms of plutonium, though sophisticated bomb makers could make do with less of either one. "Timely detection" is similarly figured to equal the amount of time that would be needed to make a nuclear device, which could be as little as a week with plutonium already in its metallic form.

At best, the aim is to detect the diversion, not to prevent it, and to make the detection in enough time to give the diplomatic community a chance to act before the bomb goes off. As David Fischer has described it, this timely warning is supposed to serve as "a burglar alarm which allows the diplomatic police to rush in and apprehend the offender before he blows open the safe." The hope, of course, is that the threat of detection would deter any would-be nuclear nation from diverting any significant quantities of either plutonium or highly enriched uranium.

How safe are the IAEA safeguards? Do they do even this limited job? The answer is more complex than many critics have suggested.

In the past, the system has worked reasonably well to give continuing assurance that a safeguarded country was not diverting nuclear material. This was useful in the highly industrialized countries, which had easy access to large quantities of highly enriched uranium or plutonium from their own or their allies' nuclear research and power programs. Especially in the case of the three major defeated countries of World War II—Germany, Italy, and Japan—the system helped to remove any lingering fears that they might be attempting a nuclear comeback. In these situations, the safeguards built trust and reduced the likelihood that any nasty surprise might disturb the existing strategic nuclear balance.

Even today, the same highly industrialized nations—from Canada and Sweden to Germany and Japan—could still make nuclear weapons if they wanted, and in a very short space of time. They have the skill, and most of them already have enough highly enriched uranium or plutonium close at hand. But they have all made a political decision not to build the bomb, and the IAEA safeguards tell the world that they are keeping their word.

In those situations, where countries are not building the bomb, the system works well enough. But in countries like Iraq and Pakistan, where they are, the safeguards are anything but safe.

"I believe that the Iraqi nuclear program was organized for the purpose of developing a capability to produce nuclear weapons over the next several years," explained former IAEA safeguards inspector Roger Richter in his dramatic testimony before the Foreign Relations Committee of the United States Senate right after the Osirak bombing. A nuclear engineer, Richter had just resigned as the only American inspector in the IAEA section responsible for safeguarding nuclear facilities in Israel, India, Pakistan, and Iraq.

"The role of the inspector is limited to verifying only material declared by Iraq or France," Richter testified. "You have no authority to look for undeclared material. Your job is to verify that the declared material accountancy balance is correct. You are not entitled even to look at the other facilities if Iraq has not adhered to its obligations under NPT to report to the IAEA that material subject to safeguards is located in these facilities," he warned.

As Richter described it, the inspections and accounting procedures would probably be able to detect any diversion of the highly enriched uranium fuel. But they would probably miss any attempt to produce plutonium by blanketing the Osirak reactor core with natural uranium rods, or targets.

"The IAEA does not look for clandestine operations," the former inspector reminded the Senators. "The IAEA, in effect, conducts an accounting operation."

Even in that, the Iraqis had the upper hand. Like every other country subject to safeguards, Iraq could and did veto inspectors from any country it did not like, Richter reported. All but one of the inspectors approved by Iraq came from the Soviet Union or Hungary. The one exception was from France, which was supplying the Osirak reactor. "As an accepted inspector, you must keep in mind that any adverse conclusions you might reach as a result of your inspection would have to take into account your country's sensitivity to how this information might affect relations with Iraq," he explained.

Next, the inspectors were limited to three inspections a year and had to give several weeks' notice that they wanted to visit those installations that were in fact subject to safeguards. The Iraqis could and did suggest alternative dates, which would give them every opportunity to hide any illicit operations. "Since the entire reactor can be emptied of the clandestine uranium target specimens within days, you as an inspector face the fact that by the time you arrive to verify the declared inventory of fuel elements which power the reactor, all evidence of illicit irradiations could be covered up."

Both the IAEA and the American Government have since criticized parts of Richter's testimony, arguing that negotiations with the Iraqis were still going on and that many of the problems that he was raising were in the process of being solved. But in the course of our investigations, we heard many of the same criticisms of the safeguards system, both from former top officials of the IAEA's Safeguards Division and from outside experts. Some of those on the inside were reluctant to speak as frankly as they or we wanted. Warren Donnelly, a research associate at the Library of Congress, told us why: "The inspectors don't like to be too open about their own criticisms. It's like getting a dentist to criticize the work of another dentist, or a doctor telling you that his colleague messed up on a surgical operation. These are the kind of things you don't say openly, only inside the shop." Any time the criticisms have been made publicly, mainly by former inspectors willing to speak out, IAEA officials offered assurances that, even if there had been problems before, everything was now under control. It should be noted that Roger Richter broke the rules of the club, and was ceremoniously fired from his job in IAEA about ten days after he himself had resigned.

Of course, those of us on the outside have little way of knowing just how effective the controls are, as the IAEA is obliged by its regulations and agreements to keep its reports confidential, and they are never published. This does not seem to us the best way to encourage accountability, or to build public confidence in the system.

The most glaring problem, however, and a fatal weakness of the international safeguards system, is that any country can simply opt out of it after it has the nuclear equipment it wants, and that includes countries that have signed the Nonproliferation Treaty.

"Now, safeguards are not foolproof," explained one highly placed American official, in an interview following the Israeli bombing of the Osirak reactor. "But even if they are somewhat effective, what if Iraq drops out of the NPT? What protection is there against that? There was a piece of paper between Iran and Iraq, all signed and sealed, and what happened there? A war."

Dr. Abraham Friedman, once the Director of International Programs for the U.S. Atomic Energy Commission, raised the same concern. "If a country concludes that for national security reasons it does not want to be part of the NPT, it could give three months' notice," he told us. "The safeguard obligation would still hold in principle, but it could simply say to the IAEA that it was not permitting inspections. The assumption is that, if a country felt strongly enough, it would simply ignore the treaty."

This, then, is the answer of the community of nations to the problem of stopping the spread of nuclear weaponry: Under the Nonproliferation Treaty a nation that wants the bomb can buy whatever nuclear technology it wants. Once it has the goods on its soil, it can leave the treaty at its own discretion, giving three months' notice. No penalties are prescribed within the treaty. It's all legal and fully aboveboard.

What, then, is the good of having a treaty? Signing it is an excellent and not even a particularly clever way to be able to buy the technology to make the bomb.

Update

Agency responds to Morgans criticisms

Last year considerable publicity was given to a report on the effectiveness of safeguards prepared by E. Morgan, a former IAEA inspector. A document replying in detail to the criticisms has recently been issued by Hans Gruemm head of the Agency's Department of Safeguards, from which the following article has been extracted.

Towards the end of 1981, a great deal of media attention was given to the so-called Morgan report, which was prepared at the request of the NRC by a former Agency employee, Emanuel Morgan, who had served for three-and-a-half years as an Agency inspector until August 1980 and performed inspections in Euratom countries and in Japan. The report was not cross-checked or discussed with the IAEA or any of its officials and was not officially transmitted to the Agency.

The press, quoting partially from Mr Morgan's paper, asserted that the IAEA was "incapable of detecting the diversion of a significant quantity (of nuclear material) in any state with a moderate to large nuclear establishment". However, it is not always easy to comprehend the nature or purpose of Mr Morgan's comments. Also, he provides only occasional substantiation for them and presents them in a somewhat incoherent way. None the less, it is apparent that many of them are simply inaccurate or point to problems which have been recognized for some time. Others refer to existing problems of safeguards implementation which are either low priority items or items which do not appreciably affect safeguards effectiveness.

It is important to note that much of Mr Morgan's experience relates to an atypical transitory period when there was a rapid build-up of safeguards activities in the countries concerned. Within two years, the number of safeguarded nuclear facilities in these areas increased by over 250, which was not matched by proportionate staff increases.

It is perhaps significant that during his whole period with the IAEA Mr Morgan made only two minor comments on accounting discrepancies in his inspection reports, despite the fact that inspectors are required to report any shortcomings they observe. When leaving the IAEA he wrote in his letter of resignation: "I have enjoyed my employment with the IAEA and would welcome future opportunities for association with the IAEA".

It is not clear what prompted Mr Morgan to write his report when he did, about one year after his separation. The somewhat incoherent, personalized way in which some of the criticism is presented by Mr Morgan makes it difficult to understand fully the object of the criticism or its relationship to safeguards effectiveness.

Some of Mr Morgan's statements are reproduced below and then briefly commented upon.

Statement. The IAEA is incapable of detecting the diversion by partitioning* of a significant quantity or of several significant quantities† in any state with a moderate to large nuclear energy establishment.

Comment. Such a diversion scenario would involve different types and classes of material and a concerted effort by a large number of nuclear installations, operators and their staff and therefore would be an unattractive high risk strategy. The basis for Mr Morgan's statement seems to be the unavoidable uncertainties of measurements leading to inventory differences – material unaccounted for (muf) – in material balance areas in bulk handling plants. But it would be wrong to conclude that this would provide an easy possibility for diversion of nuclear material in quantities within the uncertainties of muf.

Statement. The IAEA's inspectorate is very responsive to concerns of the countries which it inspects. A complaint via the Board (of Governors) can end, or alter the career of an IAEA employee.

Comment. There has not been a single instance where routine evaluation of inspection results and data evaluation at headquarters (which is not done by the inspectors) showed bias of an inspector towards the country inspected. On the contrary it has been suggested that inspectors often press too hard. The inspectors enjoy protection under the Staff Regulations and there is no objective basis for the allegations concerning inspectors' careers.

Statement. Nationals within the Agency of the country inspected have access to inspection reports, seals, seal records, etc., that concern their own country.

Comment. Access to this kind of information on a need-to-know basis is inevitable in an international organization with an international secretariat and with limited manpower resources. However, no inspector is sent for negotiations or inspections to his own country. All inspection reports are cross-checked by several supervisors and an evaluation section so that staff of different nationalities is involved. Any attempt to manipulate inspection results by a staff member in favour of a particular country can be practically excluded.

Statement. If a plant operator says that no fuel will be processed for one month, the IAEA will stop sending inspectors for one month.

Comment. The frequency of inspections is not based on operators' statements alone but objective criteria. If a reprocessing plant is shut down and if no plutonium is present in the plant, the plant is sealed and inspected only at a reduced frequency.

Statement. The inspector is often doomed from the start by an inadequately negotiated "facility attachment", (the facility attachment contains the safeguards procedures for a particular facility).

Comment. Facility attachments which contain the technical procedures to be applied follow a standard pattern wherever possible. They are carefully negotiated, reviewed to ensure standardization and compatibility with other similar situations and updated whenever necessary.

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*Partitioning is diversion of a small quantity of nuclear material from each of a large number of nuclear installations.

†8kg plutonium and 25kg highly enriched uranium.

Statement. Typically research reactors are inspected infrequently, perhaps once annually.

Comment. Small research reactors which contain small amounts of nuclear material, often less than one significant quantity, are inspected with low frequency, sometimes once a year. However, research reactors which contain large amounts of fissile material or which have the potential of producing significant quantities of plutonium are inspected more frequently, the frequency depending on the amount and type of nuclear material present in the plant. Where necessary optical surveillance is used in addition.

Statement. Tank calibrations at reprocessing plants are only rarely carried out by the IAEA.

Comment. Such calibrations are a routine matter and are performed periodically also after the plant has commenced operation.

Statement. In the case of facilities involving sensitive information, such as reprocessing plants and enrichment plants, design information review is typically not permitted.

Comment. Complete design information is available and reviewed for reprocessing plants. In accordance with the terms of the Agreement and for security reasons some information is not physically transmitted to the IAEA but reviewed at the plant, where it remains available for IAEA use. A similar situation pertains for the enrichment plants under IAEA safeguards.

Statement. Mr Morgan saw great differences between the quality of the accounting records from state to state and, within a state, from installation to installation.

Comment. The quality of accounting records varies from country to country. However, the minimum information to be available from the records is prescribed by the safeguards agreements and adhered to. None the less improvements are possible and more standardization would obviously facilitate the IAEA's task and the IAEA is actively seeking to achieve that goal.

Statement. There are difficulties with transit accounting.

Comment. The IAEA is experiencing certain difficulties with computer processing of accounting data for international transfers of nuclear material submitted by the states, and a considerable effort has to be spent to match these reports manually. In order to overcome these difficulties the IAEA convened a meeting of consultants which resulted in recommendations to the IAEA and to Member States. These recommendations will be implemented in 1982. Their implementation will allow the Agency to establish a highly efficient computerized system for international transit accounting of nuclear material.

Hans Gruemm, Director, IAEA Department of Safeguards.

Statement. The post-mortem examination of seals is not necessarily capable of determining whether the seal was surreptitiously opened and reassembled. The IAEA uses also paper seals.

Comment. Seals placed on nuclear material are not easily counterfeited or duplicated. A special "fingerprinting" system and periodical change of seals for subsequent detailed investigation make IAEA seals highly tamper resistant. Paper seals are used by IAEA as well as in domestic safeguards systems as a stress indicating device. They are used only for short periods or under special conditions of low safeguards relevance.

Statement. There have been significant improvements recently in reliability of surveillance cameras but failures still occur at an alarming rate.

Comment. Camera reliability has improved substantially. Furthermore, use is always made of twin camera systems or a c.c.t.v. back-up system so that the IAEA never relies on one camera only. Cameras are tamper-indicating and are checked at intervals which correspond at least to the detection time for the nuclear material in question. Safeguards procedures do not rely only on containment and surveillance measures. In cases of doubt should a failure of a camera system occur, the complete inventory of the nuclear material under surveillance is re-verified by inspection.

Statement. A credible diversion path for nuclear material is constituted by measured discards.

Comment. Measured discards consist of nuclear waste containing nuclear material in minute quantities the recovery of which is quite impracticable. In view of the quantities of nuclear material involved and the technical effort required to recuperate such material this is regarded as an implausible diversion scenario which is not urgent. However, the problem is being addressed.

Statement. Mr Morgan describes a rather complex scenario for diversion of plutonium from a reprocessing plant which is based on bypassing the accountability tank.

Comment. This particular diversion scenario was brought to Mr Morgan's attention during his training as an inspector by his supervisor. The present practice calls for 100 per cent verification of input dissolver solution so that such an unlikely scenario is also taken into account.

Statement. Burn-up calculations are not even done by the IAEA on an occasional basis. Neither are isotopic techniques applied.

Comment. Isotope correlation techniques are applied by the IAEA and so are burn-up calculations as a matter of routine.

Statement. Mr Morgan refers to problems in safeguarding a critical assembly containing large amounts of plutonium and relating to on-load refuelled reactors.

Comment. There are complex technical problems associated with safeguarding certain types of plants. With regard to the critical facility the desirable improvements have been made. The specific problems with respect to on-load refuelled reactors have been addressed previously on a number of occasions, and more recently by the Director General in reports to the Board of Governors. Measures to deal with these problems have been taken but it is inevitable that in the field of technical complexity continuous development efforts are required.

Statement. The possibility of irradiation of additional fuel contained in normally non fuel-bearing structural components of the fuel assemblies was not covered by the inspection approach for power reactors.

Comment. This is not a very attractive diversion possibility and not a priority item. Nevertheless it was addressed by the IAEA in a request for analysis by the US Support Programme. The report was useful in designing adequate inspection measures which are being implemented. ☐

STATEMENT BY HANS BLIX, DIRECTOR GENERAL
TO THE IAEA BOARD OF GOVERNORS, FEBRUARY 24, 1982

Mr. Chairman,

Throughout the Statute of the IAEA there runs the aspiration to promote the peaceful use of nuclear energy and other peaceful applications of nuclear science and the aspiration to prevent the spread of nuclear weapons.

At this point I should like to lay before you some preliminary views on the safeguards system. The meeting of the Board in June will give an opportunity for a fuller discussion, but I think an exchange of views already now would be useful.

The safeguards system has been the subject of a good deal of public criticism in the past year and while I think constructive criticism of the system should be welcomed and be made use of, I fear some of the criticism emerges from misunderstandings of the Agency's role and of what the Agency safeguards' system can do. It is evidently for the Agency itself, but also, I think, for member governments to try to correct such misunderstandings and to create a correct image.

The safeguards system is not, of course, an end in itself. It is a part of an effort to prevent any further spread of nuclear weapons. It is a unique verification system under which governments invite the Agency to undertake on-site inspection in order to demonstrate that no nuclear material is diverted to non-peaceful purposes from safeguarded nuclear facilities. The IAEA is not a police force. It provides a service. Where safeguards are applied effectively to all of a country's nuclear facilities, they are likely to inspire confidence and to reduce tension regionally and internationally.

This system cannot, however, of itself prevent proliferation. The Agency can do little more than verify, report and recommend. The prevention of any further spread of nuclear weapons depends, above all, upon governments reaching the conclusion that it is in their interest not to acquire such weapons.

Thus, while the Agency has the duty to ensure that its verification procedures are such that all its statements have full credibility, it is only the governments which, through their foreign policies and relations, can create international and regional security conditions which favour non-proliferation.

I wanted to stress this point before going more closely into our safeguards activities, because it seems to me that the best hope at this juncture of avoiding further proliferation lies in efforts by all governments to seek to promote regional and international environments in which no state feels a need to keep open a nuclear weapons option.

Very much has, of course, been accomplished. The Non-Proliferation Treaty (NPT) has now 115 parties and 98% of the world's nuclear facilities outside the nuclear-weapons states are today under IAEA safeguards. It is obviously for governments to judge what measures should be taken to make further progress. Egypt's adherence to the NPT last year was a major welcome step.

But we would need to see further steps in a similar direction: new adherences to the NPT, acceptance of full-scope safeguards, e.g. under the Tlatelolco Treaty, creation of nuclear free zones, voluntary invitation to inspect peaceful nuclear facilities in nuclear weapons states. Such steps would inspire needed hope. By contrast any steps toward a nuclear explosive capacity, or worse still, any nuclear explosion, could start an erosive and dangerous process.

Whether we shall see the one or the other evolution is not merely a matter of chance, but is subject to government's influence. I have referred to foreign policies. I must also mention the more positive light in which many states would view the NPT, if more substance were given to the promises about the transfer of peaceful applications of nuclear science and technology, inter-alia through the Agency's programme for technical cooperation with developing countries. And I must mention that an ever expanding vertical proliferation of nuclear weapons and deployment of ever new types are not helpful in bringing about the aim of the Treaty.

Let me turn now to the more limited but vital question of how we can achieve a further strengthening of IAEA's safeguards as a part of the non-proliferation regime.

Half way through the initial span of the NPT and 25 years after the IAEA was born it seems timely to take stock and to try to identify our goals and objectives for the years ahead and seek to remedy the shortcomings we find.

The very rapid expansion of safeguards in the last five years has inevitably entailed uneven growth in some areas and certain managerial problems. The techniques of safeguards and the scientific tools at its disposal are also rapidly evolving.

In the Secretariat I suggest that our main aim should be towards a motivated and efficient career Inspectorate, effectively organized for the tasks before it. The inspectors must all feel that they are part of a vitally important international operation, a pioneering venture, in which governments for the first time seek international detente by inviting inspections on their soil. They must also feel that with their help and advice we shall remedy such shortcomings as are within our competence.

The events of 1981, the unduly high turn-over rate amongst inspectors and a recent consultants' survey do point to the need for some changes. Methods need to be improved and manpower needs to be increased.

I have suggested that safeguards might be regarded as a service that the IAEA renders to enable states to demonstrate that they are abiding by their non-proliferation or other safeguards obligations. It is in the inspected party's interest that this demonstration should be as convincing as possible. This, in turn, depends upon the cooperation offered by governments and their willingness to permit us to apply new techniques. But it also depends upon the safeguards operation receiving such resources as would enable it to give that degree of assurance it is inherently capable of providing.

We are, of course, aware of the financial stringency on national budgets. Adequate safeguards operations must, however, be based on adequate resources.

As a first target, the IAEA obviously needs enough trained staff to do that amount of inspection which is prescribed as a legal requirement in agreements with the Non-Proliferation Treaty Non-Nuclear Weapons States - the so-called Actual Routine Inspection Effort - and to carry out adequate inspection under other safeguards agreements.

The development and use of new instruments and techniques will also have increasing financial implications and we shall continue to need the support of member states both within and outside the budgetary framework.

In view of growing public as well as official interest in the safeguards system it is time to consider how we could enhance its transparency and what additional information could be released. A greater effort in the Agency's public information activities is called for. Perhaps a film about the safeguards system would have a greater impact than the pamphlets, lectures and interviews we are offering?

There are many other Secretariat actions identified in the annual Safeguards Implementation Reports which are being undertaken to improve the overall effectiveness of the safeguards operation, its internal procedures and its quality control. We are also taking steps to improve managerial practices and coordination within the Secretariat.

Safeguards Agreements

In taking stock of our safeguards system, there are a number of respects in which INFCIRC/66 (now 18 years old) could usefully be brought up-to-date. It should for instance enable the IAEA to employ the most advanced safeguards techniques that modern technology offers and should incorporate the experience gained since the IAEA began to apply it in the mid 1960s.

Time has also shown room for improvement in the NPT system, for instance, in the way it deals with the safeguarding of yellow cake and with facilities in which no nuclear material has been reported.

A systematic analysis of both systems in the light of experience could be useful.

These questions concern states with which the IAEA has safeguards agreements as well as the Board and require careful study and consultations.

Government Actions

Finally, may I touch on the policies of our member states in relation to safeguards.

Their full and continuing support is of course crucial for the success of the operation, as is the extent to which they require effective international safeguards as a keystone of nuclear export and import policies. At a time of growing commercial competition in the international nuclear market it is important for the stability of nuclear industry as well as for international security - that effective safeguards should remain a standard requirement of sales agreements.

The Board is aware of the problems that we have experienced in accrediting and effectively deploying the staff of the Inspectorate, usually because of government policies unrelated to the technical qualifications of the inspectors proposed. It is planned that future Safeguards Implementation Reports will contain an analysis of this serious problem as well as of measures related to the improvement of state systems for accounting and control.

I should now like to inform the Board of certain current developments.

The Government of Papua and New Guinea acceded to the NPT in January. The Government of Guatemala, also in January, ratified the NPT/Tlatelolco Safeguards Agreement which was approved by the Board and signed in 1978. Both these developments are welcome.

The Board has before it for approval under this item two draft safeguards agreements - one between the Federal Republic of Germany, Spain and the Agency to implement the safeguards provisions of a bilateral cooperation agreement between the two countries; the other between Bangladesh and the Agency, to implement Bangladesh's NPT obligations.

In more recent meetings with the Pakistan Government, productive discussions have been held on safeguards measures to be implemented within the framework of the existing Subsidiary Arrangements. This was desired by the Pakistan Government. Suggestions for implementing the Agency's safeguards proposals have been made, which could lead to considerable improvement in the safeguards at the KANUPP power station. Further discussions will be taking place in the coming weeks to ascertain whether these suggestions can, in practice, be implemented within the existing Subsidiary Arrangements in a way which secures the improvements considered necessary by the Agency. Some of the Agency's proposals for improving safeguards at KANUPP have already been implemented, and I am sure the Board shares my hope that the consultations and discussions now in train will lead to implementation of the remaining proposals as soon as possible.

In summary, progress is being made, but full implementation, including the timely development and delivery of equipment, has yet to be accomplished. This is needed before the requisite assurance of verification can be made by the Agency.

In the case of other Member States operating or constructing reactors of this type, there is agreement on the measures necessary for achieving effective safeguards. Some of these measures have already been implemented, and further implementation is being pursued at technical level with the countries concerned.

I will keep the Board informed on progress.

Mr. Chairman,

I should like to end where I started. We may be at a crucial juncture. There may be possibilities of a dynamic swing in favour of non-proliferation. More states committing themselves to foregoing the nuclear weapons option and demonstrating it by inviting safeguards, would make the world a little less dangerous. Conversely, additional nuclear explosions could lead us in the opposite direction.

The Agency must do its part by improving its operations. Positive government attitudes can help it. The security environment created by foreign policies of governments is of decisive importance.

Congressional Research Service
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SPECULATIONS ON ALTERNATIVES TO IAEA SAFEGUARDS

by
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April 9, 1982

QC 170 Gen.

The Problem

Recent criticisms and doubts expressed regarding the adequacy of inspection of nuclear materials by the International Atomic Energy Agency (IAEA safeguards), together with some concern about political conflicts among member States, pose the possibility that its safeguards may not be deemed adequate. In that event, there could be the question of what could take this place.

The following discussion of such alternatives does not presuppose an early demise for effective safeguards. Nonetheless, so much importance is attached to them as critical to the Non-Proliferation Treaty, and as a deterrent to misuse of nuclear materials, that some contingency thinking about what might take their place is warranted.

Alternatives to IAEA Safeguards

Conceptually, there are two broad alternatives to IAEA safeguards if use of nuclear power is to continue: to have some other body apply them, or to do without them. Within the first are the following variations:

Safeguards by nuclear suppliers. -- Reverting to the situation before the IAEA began its safeguards, nuclear supplier states could insist upon their own right to inspect their nuclear exports abroad. The United States would be one of the first States to inspect its nuclear exports abroad.

The advantages of this alternative include:

1. Quick application. Most U.S. agreements for nuclear cooperation already provides for "fall back" safeguards.
2. Supplier countries would be assured of the competence of the inspectors and the adequacy of their inspection.
3. Supplier countries probably would get more cooperation for their inspection than is given to IAEA inspections.
4. Supplier countries could act more quickly and probably more effectively if their inspections found a diversion.

Disadvantages could include:

1. No inspection of homegrown, indigenous nuclear materials and facilities.
2. Complications and potential confict if several suppliers assert inspection rights for the same materials or facilities, which could easily happen.
3. Confusion if various suppliers used different technical standards and procedures.
4. Risk that supplier countries would offer concessions or safeguards requirements as an inducement to get supply orders.
5. Diversions detected by inspectors of one country might not be announced to other countries.

A suppliers safeguards organization. -- To avoid confusion and disadvantages of inspection by each supplier, nuclear supplier states might form their own safeguard organization for inspection.

Advantages include:

1. Establishment of safeguards under tight control of the suppliers themselves.
2. Uniform standards and competence for the inspectors.
3. Direct information to supplier governments of diversions.
4. Less political limitations on scope and frequency of inspections.

Disadvantages could include:

1. Resistance from inspected states, especially the third world, and lack of international political support.
2. Absence of the legitimacy enjoyed by IAEA safeguards under its statute and the NPT.
3. Difficulty in getting supplier states to agree on purpose, organization, management and funding of the new body.

Regional safeguards organizations. Since most nuclear power will be concentrated in a few regions [North America, Europe and Japan], it might be possible to establish regional organizations to inspect and safeguard nuclear materials and facilities. Such organizations might be connected to Regional Nuclear Free Zone Treaties. For example, the Latin America Nuclear Free Zone Treaty [The Treaty of Tlatololco] could be amended to establish a regional safeguards organization if IAEA safeguards were not available. Other nuclear free zones if established (e.g., for Scandinavia, Southwest Asia, the Middle East) likewise could establish regional safeguards organizations.

Advantages include:

1. Verification of no-weapons pledges by inspection.
2. Much of the world's nuclear power could be covered.
3. Regional safeguards could provide more assurace to other countries than could bilateral.

Disadvantages include:

1. Safeguards among regional organization could vary in reliability and sensitivity, causing possible confusion and doubt.
2. The low probability that several regional organizations could be quickly established and coordinated, with prospects of sensitive nuclear materials and facilities going unsafeguarded.
3. In some regions, sensitive states might be able to dominate or widely influence the organization.

Doing Without External Inspection

If IAEA safeguards were to become inadequate or lose support and nothing took their place, then world use of nuclear power would proceed uninspected.

Advantages of doing without safeguards could include:

1. Increasing pressure for political steps to reduce reasons why states might want nuclear weapons.
2. Elimination of risks of misplaced confidence in safeguards.
3. Compelling big powers to prevent undesirable nuclear activities by states within their spheres of influence.
4. Could give impetus to international control or organization for reprocessing, plutonium management, spent fuel storage.

5. Receiving attention to sanctions and preemptive actions as deterrents to nuclear weapons spread.

Disadvantages could include:

1. A potential crippling of the NPT, since its no-weapons pledges would not be verified by inspection.
2. Increased suspicions by states of nuclear activities of their neighbors, giving rise to greater probability of preemptive actions.
3. Possible collapse of international constraint on nuclear exports, thus opening the way to further spread of undesirable nuclear plant and materials.
4. A fatalistic acceptance of more weapons spread.
5. Discrediting of international inspection for arms control and disarmament.

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Remarks by Victor Gilinsky
Commissioner, U.S. Nuclear Regulatory Commission
before the
Washington Chapter of the
California Institute of Technology Alumni Association
Washington, D. C.
October 28, 1982

MORE NUCLEAR WEAPON STATES?

In the current revival of concern about nuclear war, the emphasis has been on the danger of increasing numbers of Soviet and American nuclear weapons. I'd like to raise with you a related and equally serious concern, one which is being overridden by competing commercial interests. I am talking about the prospect that more and more countries will possess nuclear weapons.

This prospect is especially worrisome when you think about it in concrete terms: nuclear weapons in the hands of more national leaders. We know what some of them have been like.

With more nuclear-armed leaders there will be more occasions when the use of these weapons is contemplated, or even threatened. This is bound to make their actual use more likely. And if it comes to that, we and the Russians may find it impossible to avoid getting drawn in. Imagine our predicament in a nuclear war among Middle Eastern states. In fact, of all the events which might trigger U.S. and Soviet nuclear arsenals, I would not, by any means, put this at the bottom of the list.

We should not assume that countries with small nuclear arsenals will be as cautious as we are. A high-level scientist in one of the near-nuclear countries once said to me: "You Americans overestimate our ability to produce nuclear weapons, but you underestimate what we will do with them if we have to use them."

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activities described than about the corruption of the term "peaceful" in nuclear usage.

If the activities we have talked about are really intended for peaceful use, then why the secrecy? The presumption has to be that these countries have military uses in mind.

NPT AND INTERNATIONAL INSPECTION CAN'T COPE WITH NUCLEAR EXPLOSIVES

If these countries are genuinely interested only in the use of nuclear energy for the production of power, they have the opportunity to adhere to the Nonproliferation Treaty and permit inspection by the International Atomic Energy Agency. We should continue to press for this.

I do not, however, want to leave you with the impression that NPT adherence and acceptance of IAEA inspectors solve the problem. International inspection is, at best, only part of the answer. The way the NPT has been widely interpreted, all nuclear activities short of the actual manufacture of weapons are legitimate so long as they are covered by IAEA inspection. Signatories are required only to pledge not to manufacture nuclear weapons. But such pledges can be withdrawn quickly, and the warning system based on international inspection is frail and only marginally effective.

The inspections can offer reasonable protection, at least in principle, for what we might call "safe" technologies. This includes most of the equipment and materials related to power operation: today's power reactors and their relatively benign low-enriched uranium fuel, and even the plutonium that is still locked inside highly-radioactive spent fuel. But when a country steps over into the "dangerous" technologies involving highly-enriched uranium and separated plutonium, it's a different story. Then, once it has done its nuclear weapons homework, a country can put the explosive material to bomb use almost overnight. That is why ownership and physical control of such material, even if covered by international inspection, is nearly tantamount to possession of nuclear weapons. In these circumstances, countries cannot rely on the inspection system to warn them in time that a neighbor is suddenly making bombs. (That fact must have contributed to Israel's attack on Iraq's nuclear facility.) The obvious conclusion is that nuclear explosives must be kept out of civilian power programs if these programs are to be kept at a safe distance from bombmaking.

EXPLOSIVE FUELS UNNECESSARY FOR NUCLEAR POWER

In retrospect, there is no question that we should have separated the civilian and military atoms more than we did. The really dangerous explosive fuels -- plutonium and highly-enriched uranium -- and their production plants are not essential for gaining the benefits of nuclear energy. In fact, they play almost no role in the U.S. commercial nuclear power program.

We got off on the wrong foot years ago, however, by directing our research and development programs almost exclusively toward the use of plutonium fuel. Plutonium then appeared economically attractive for the future because uranium was thought to be scarce. It seemed to make sense to shift as soon as possible to plutonium-fueled advanced reactors. Following the U.S. lead, nuclear bureaucracies and industries worldwide committed themselves to an eventual shift to plutonium fuel.

The international security implications of this received scant attention, among other reasons, because it was widely thought that commercially-generated plutonium was unusable for weapons. This is dead wrong, but it is still used in arguments, sometimes by persons who know better. Also, bombs were thought to be so difficult and expensive to design and fabricate that possession of the material in itself did not seem particularly dangerous. This, too, is wrong; with the inevitable diffusion of information and skills over the years, making bombs is no longer the hurdle it once was.

The economic assumptions on which plutonium programs were based turned out to be erroneous as well. The cost of reprocessing radioactive spent fuel has gone way up, and the cost of uranium has gone down. The commercial incentive for plutonium-fueled systems has evaporated.

And we now know that the highly-enriched uranium, used to fuel research reactors, can be replaced with less dangerous material of lower enrichment.

There is no question, in other words, that we can enjoy the benefits of nuclear energy perfectly well without involving ourselves with fuels that are also explosive. President Ford made this point in 1976 in announcing a new policy for nuclear power. He said that plutonium should not be put into commercial use until the world can overcome the associated risks of proliferation. But even without plutonium, he said, the United States and other nations could increase their reliance on nuclear power.

BERTRAND GOLDSCHMIDT
THE ATOMIC COMPLEX
(Excerpt)

2. Safeguarding Nuclear Energy

Origins

The first 10 years of atomic energy were thereby marked by considerable technical progress, by the construction of the first large-scale industrial nuclear power stations, and by the launching of a growing number of autonomous programs for the production of nuclear electricity.

During this same decade, political problems were sufficiently resolved to encourage the start of international nuclear trade and to allow some new countries to join in the industrial atomic adventure.

From as early as 1956, the U.S. Congress, together with the U.S. Atomic Energy Commission (U.S. AEC) and the State Department, had insisted that any transfer of nuclear materials to foreign countries should be conditional on acceptance by the importing state of the U.S. right to verify, by inspection, the uses to which the materials were put. Until the establishment of an international safeguards system, as already envisaged in successive draft statutes for the International Atomic Energy Agency (IAEA), the inspections were to be carried out by Americans.

The safeguards clause was a remarkably original condition. For the first time, materials that were physically and chemically identical were to possess different political properties. Their use could be either free or restricted to peaceful purposes by verified international commitments. As already noted, such safeguards were intially accepted without complaint by the nations concluding agreements with the United States.

On the other hand, by imposing these safeguards, the American government was putting the country at a disadvantage for future international competition as long as imposition of a similar condition was not generally and equally insisted upon by all nuclear suppliers. For with other conditions being equal, any importing country, even without military ambitions, would obviously opt for supplies over which it would have full control rather than materials subject to international inspection.

It was therefore very much in the United States' interest to secure an extension of this policy to the entire international market, by persuading as many countries as possible to apply the same export regulations as those imposed by Congress on American sales. At this stage only the United Kingdom and Canada, in accordance with the spirit, if not the letter, of the Quebec Agreement, were more or less obliged to follow suit.

Winning over the other countries therefore became a major objective for Washington, not only from the viewpoint of nonproliferation but also to overcome the commercial handicap resulting from the peaceful utilization clause. This was not to be the last time that the American government, to avoid becoming the victim of conditions imposed by its own Congress, tenaciously sought to make other countries apply these same conditions.

But the Americans at that time held a major trump card: the monopoly of enriched uranium supplies in the Western World. Only the Soviet Union could have countered this monopoly, and some 15 years were to pass before any such competition appeared. However, Washington's position over natural uranium was less strong and was soon to become even weaker, for from 1960 onward the U.S. AEC budget no longer enabled it to buy up the whole of the Western World's production.

Hence the adoption of the peaceful use condition by the exporters of natural uranium became a major objective of American policy, the more so because the future competitors of the United States in the markets for research reactors and power plants were to come from countries working with natural uranium.

Among the countries able to offer this reactor type, the only one not bound by the Quebec Agreement was France, who found herself in a double difficulty over the American policies: first, as a potential buyer of uranium on the world market for her civil (and perhaps also military) programs, and second as a potential exporter of natural uranium reactors. Thus, in the early days of the development of international safeguards policies, Paris was to find itself frequently in conflict with Washington.

Birth of the IAEA

As mentioned earlier (see p. 118), the first signs of dissatisfaction with this American policy appeared in 1956 during the preparation of the IAEA statutes; in particular, the clauses relating to the two "extremities" of the fuel cycle — safeguards on natural uranium and the future of plutonium produced in the reactors.

Until then, natural uranium had in fact been the only area in which the United States and the United Kingdom had shown interest in international collaboration, through their postwar extraterritorial prospecting programs for that mineral. For these ventures, no restrictions on its subsequent use limiting it to peaceful projects had been proposed. Indeed, since neither the United States nor the United Kingdom would have accepted such a restriction affecting their own uranium imports, they could hardly have imposed it on the producing countries.

This is why the financial help given for uranium prospecting in South Africa and Canada in the early 1950s, as well as for the unrewarding searches in Morocco (see p. 108), did not involve restrictions on the use of any share of the uranium found within their borders that those countries might retain. Such uranium therefore remained free for any use by themselves or by future importing countries.

The question of safeguards on natural uranium was raised during the preparatory conference for setting up the IAEA, held in February 1956 in Washington. The 12 countries* taking part included advanced industrial powers, uranium producers, and leaders of the Third World. During the month-long conference, the United States, determined that the new agency should have a technical character, with some difficulty obtained agreement that the most technically advanced countries together with those producing uranium — later to form themselves into a suppliers' group — should have a dominant role in the organization's administrative council or "Board of Governors." The initial composition of this board (23 members) involved bitter discussions with the Third World delegates, who considered their countries insufficiently represented.

Nonetheless, the decision to invest the agency with powers of safeguards and inspection was generally welcomed. These powers were to be applied in all agreements for the supply of materials in the agency's possession, as well as, and above all, in bilateral or multilateral agreements whose civil nature the partners sought to guarantee through the agency's safeguards system, and also in cases where member countries might unilaterally request safeguards applications to their own programs. Despite opposition from the Soviet side, which wanted the countries concerned to meet the costs of the safeguards themselves, it was decided that the agency should accept the financial burden, the safeguards being considered a contribution to the protection of world peace by reducing mutual suspicion and distrust among nations whose atomic programs would involve militarily significant quantities of fissile materials.

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*Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Portugal, South Africa, the Soviet Union, the United Kingdom, and the United States.

While making no objection to safeguards on the "special fissile materials" — enriched uranium and plutonium — the Indian delegation was opposed to their application to natural uranium. The delegation felt that such a far-reaching system would inevitably divide the countries of the world into two categories. On the one hand, there would be those having no indigenous uranium. Because they would now be unable to secure supplies through the normal commercial market, these countries would be condemned forever to safeguards — even in the civil field, which was the only one where they could hope to develop. On the other hand, there would be the uranium-rich countries and the Great Powers with their military programs. For these countries there would always be supplies of nonsafeguarded, freely usable materials, which they could make available for their civil development, so protecting this from the risks of industrial espionage that are made possible by international inspection.

This was the first hint of a complex and obstinate Indian policy in atomic affairs, continually in the forefront of the campaign for nuclear disarmament and for an end to test explosions, and simultaneously championing nuclear independence for the nonaligned countries of the Third World. Of these last, India was at the time by far the most advanced in the atomic energy field.

The U.S. delegation, widely supported by most of the other states represented at the Washington meeting, rejected the Indian view. The Americans found it particularly unwelcome because, with an overabundance of uranium beginning to appear, they foresaw a time when they could no longer afford to renew their purchase contracts with Canada and South Africa and when uranium supplies would be available on the world market. In fact, they were beginning to put pressure on these two countries to make all future sales of uranium (except of course to the United States or to the United Kingdom) conditional on a guarantee of peaceful use and on the acceptance of international safeguards. Because these uranium-producing countries still hoped to maintain some of their sales to the United States, the American pressure was all the more effective.

The New York Conference

This was the situation when, in October 1956, representatives of 81 countries assembled in New York for the final negotiations on the IAEA statutes. It was, 10 years after the failure of the Baruch Plan, the first time that countries from all over the world had met at U.N. Headquarters to discuss ways for developing nuclear energy without the risk of encouraging its military applications.

During the previous summer, the French government had learned that Canada, although anxious to find new outlets for its uranium, could not supply it to France under "nonrestricted" conditions, i.e., under the same conditions that applied to the United States and the United Kingdom, who could use it for military purposes as and when they wished. Prior to this, Paris had in fact attempted, without success, to persuade the American government not to oppose a possible supply of Canadian uranium to France without restrictions on its use.

Under these circumstances the French delegation to the New York conference, led by myself, had been instructed to accept the principle of safeguards on enriched uranium and plutonium — both being substances of military significance prepared only with considerable industrial effort — but to oppose safeguards on natural uranium, in view of its wide geographical distribution and the discriminatory nature of any such controls.

In presenting this view to the meeting, I also called more generally for a "reasonable application" of the safeguards policy. In my opinion, the IAEA's slogan at that time should surely have been "once a client, always a client," rather than "once safeguarded, always safeguarded."

My intervention, completely contrary to present nonproliferation policies, whose object is precisely to keep the entire nuclear activities of nonnuclear weapons states under IAEA control, was considered by the Washington government to be deplorable. French Ambassador Hervé Alphand was summoned by U.S. Deputy Secretary of State Robert Murphy and I was obliged, in a second intervention, to tone down my initial declaration. The new American control philosophy was already a virtual dogma that must be accepted in full without discussion.

The French position was, in fact, one of the first expressions of dissatisfaction over the inevitably discriminatory nature of any effective nonproliferation policy. The French attempt to exempt natural uranium from safeguards and to restrict guarantees of peaceful utilization to the fissile material concentrates, enriched uranium and plutonium, had no technical justification. This attempt reflected France's wish for independence, if not her further intention to avoid control of natural uranium reactors in view of possible military requirements. In the end the attempt failed and the IAEA statutes made no distinction between natural and enriched uranium from the viewpoint of safeguards.

The French attitude had been shared by the developing countries, led by India, and by all the eastern countries except the Soviet Union, which at the beginning of the conference appeared to support the other countries already in possession of fissile materials. However, by the end of the conference, which was very animated, the Russians had joined ranks with those opposing controls.

India's position was clearly described by Homi J. Bhabha, whose personal prestige was considerable. He particularly attacked the perpetuation of safeguards through the successive transmutations of fissile substances, a vital matter for his own country where source materials existed but where external help was needed for the early stages of the program. He pointed out the illusory nature of strict safeguards, emphasizing that any aid in the atomic field, whether in personnel training or in the supply of nuclear materials, was potential military aid since it was bound to lead to the acquisition of new knowledge and could make available indigenous materials for potential military use. Bhabha proposed that IAEA aid should be given only to countries with no military program, a philosophy close to that advocated today by those who want to see assistance given solely to nations whose entire nuclear activities are subject to safeguards.

Last, the point on which the Indian delegate declared he would never give way was his total opposition to a clause that would have given the IAEA, in all projects subject to its control, the right to decide the future use of all the resulting plutonium, and to fix the quantity that each country should be allowed to keep for its safeguarded civil uses, the rest being deposited in the safe keeping of the IAEA itself. To endow the agency with such discretionary powers would be to risk giving it too great a hold over any country with an economy based on nuclear electricity produced through a program to which the agency would have contributed nothing beyond its earliest stages.

Negotiations between the American and Indian delegations continued throughout the conference. The Americans refused any substantive modification of their position, being totally opposed to the holding of plutonium stocks by nonnuclear weapons states, even if these stocks were subject to

IAEA control. This was to be the thesis readopted, 20 years later, by President Jimmy Carter when it became fundamental to the new American nonproliferation policy.

On October 19, 1956, the day the conference was due to end with a vote on the safeguards clause, the Soviet Union, whose position until then had remained uncertain, joined the other socialist countries in opting clearly for the Indian position. Seeing that the vote was likely to lead either to deadlock or to the adoption of the American proposals by only a small majority, the Swiss delegate, Ambassador Auguste Lindt, and myself decided to put forward a conciliatory amendment. This amendment gave countries the right to retain, from the plutonium they produced, the amounts they needed for their research programs and for their existing reactors and those under construction.

The American delegation requested 48 hours to consider this proposal. The matter was put before the secretary of state, John Foster Dulles, and even the president. After lengthy discussions, the three Anglo-Saxon delegations accepted the Franco-Swiss proposal, to which the Indian delegation also agreed.

Therefore, the conference ended in an atmosphere of unanimity, though failure had been only narrowly avoided. Finally the last obstacle had been overcome, and the way was clear for the creation of the IAEA and its inspection system, a system that would allow countries supplying nuclear aid to verify that it was used for purely peaceful purposes.

It is interesting to note that the much discussed clause concerning the agency's rights over the storage of excess plutonium has never been implemented. The clause has nonetheless acquired new relevance, twenty years later, as the evolution of nonproliferation policies has called for a legal basis for the international storage of plutonium extracted from spent fuels, while awaiting reuse in appropriate power reactors, notably in fast breeder plants.

France, although ready to submit her civil nuclear activities to the future control system of Euratom, had considerable reservations over the IAEA's safeguards, which she did not accept for her national projects until 20 years later, and then only in certain well-defined cases. In fact, in July 1957, during the debate in the French parliament on ratification of the international agreement establishing the IAEA, the government was requested not to make any request for aid from the new organization. It was considered vital that no part of the national effort should be submitted to international safeguards in which inspectors from unfriendly powers could participate. This condition was tacitly accepted by the government.

Safeguards on Natural Uranium

During the few months between the eventful adoption in New York of the IAEA statutes and this debate in the French parliament, a new dimension had been added to the problem of safeguards when France pursued negotiations with Canada for the purchase of uranium.

A decision had to be made on the source of part of the fuel for Electricité de France's nuclear power stations, as there appeared to be a choice between opening a new mine in Central France, which would lead to costly investments, or buying the necessary uranium from Canada. Should the latter solution be adopted, the French government was prepared to consider international controls restricting the Canadian fuel to peaceful uses, the country's indigenous resources remaining available in case of military need.

The Canadian negotiations were entrusted to me. They took place in Ottawa, in March 1957, through a renewable purchase contract for some 50 to 100 tons of uranium. Agreement was reached on quantities and on the safeguards, which were to be applied by the Canadians themselves for the French government considered IAEA controls inappropriate in a transaction between two North Atlantic Treaty Organization allies. There remained the question of price, for which I had express instructions. The Canadians suggested the same average price as paid to them by the Americans, which was $11 per pound of oxide. To their surprise, I replied that we could only accept the same price for the same material (in other words, if the uranium were similarly free of restriction) and that an imposition of the clause on safeguarded peaceful utilization should entail a substantial discount. As the French government had expected, the negotiations broke down on this point, to the great regret of the Canadians who, in view of their obligations vis-à-vis the United States, could sell to France neither nonsafeguarded nor cut-price uranium.

This was one of the first brief appearances of dual pricing, resulting from safeguard policies, in the world market for nuclear materials. Prices were dependent on whether the materials were sold free from restrictions or limited to purely civil applications.

Another example concerned heavy water. From 1955 onward, this substance was being offered for sale by the United States, restricted to peaceful uses and subject to safeguards, for less than half the price then charged by Norwegian industry. Despite this, Norway continued for some years to supply heavy water at the higher price both to the United Kingdom for its hydrogen bomb project and to France for a natural uranium submarine engine, a project pursued at this date but later abandoned.

However, as the IAEA safeguards became more generally accepted, and with the saturation of demand for military programs as such, the incentive behind this dual pricing diminished and virtually disappeared. Twenty years were to pass before the issue was raised again by the concept of "prior consent" from nuclear suppliers concerning their materials and the main stages of the uranium cycle.

In 1960, the United States replaced Canada as the Western World's leading producer of uranium. Shortly afterward the U.S. AEC was obliged to cease entering into new contracts for uranium purchase on the internal market, and at the same time decided not to renew existing import agreements.

The American military budget, huge as it was, did have its limits, as did the capacity of the country's uranium purification plants. So, toward the end of 1959 (as had been predicted), the U.S. government, obliged to give preference to its national producers, was forced to decide against renewal of its Belgian, Canadian, and South African purchase contracts, all of which were coming to an end in the early 1960s.

The Americans, in abandoning the markets they had themselves helped to create, gave up one of the essentials of their previous atomic policy: the stranglehold they had maintained on the principal Western sources of uranium through the Combined Development Trust created in 1943, whose purpose had now disappeared. No advocate of nonproliferation could at this stage have persuaded the U.S. Congress to vote the necessary fund for purchasing all of the now overabundant uranium. On the contrary, Congress was much nearer to prohibiting imports of foreign uranium into the country. Such a prohibition did in fact come into force in 1964.

The discontinuance of these foreign contracts was particularly serious for Canadian industry, which had been earning $300 million per year from uranium exports, the third largest source of external revenue for the country after wheat and wood pulp.

Canada and South Africa were able to soften to some extent the economic consequences of the American decision by spreading out the last deliveries of uranium that were due under the remaining contracts, which lasted until 1966 for Canada and 1970 for South Africa, and by exploiting only their richest mines. Nevertheless, a town in Ontario, Blind River, which had been built to house 25,000 people engaged in the large local uranium mining project, was reduced to a ghost town.

On the other hand, Belgium suffered hardly at all from the nonrenewal of the U.S. contracts for Congo uranium, for their principal mine was virtually worked out when its exploitation ceased in 1960, shortly before the

Congo achieved independence. Between 1944 and 1960 the mine had supplied the United States and the United Kingdom with over 30,000 tons of uranium, a quantity on the same order as the entire production of the Western World in that same year 1960. In terms of finished products, this corresponded to a turnover of about $1 billion with uranium taking third place, after copper and aluminum, in the nonferrous metal world trade.

During these times of overabundance, France was still engaged in her campaign against safeguards clauses in contracts for the supply of natural uranium. In 1959 France sold some tens of tons to Denmark and Sweden, modest sales that, at the request of the purchasing countries, were free of restrictions on use. The Euratom commission, drawing inspiration from the American philosophy of safeguards, called for these transactions to be made conditional on a peaceful utilization clause, quoting an article of the Euratom treaty that instructed it to ensure that beneficiaries of such deliveries "gave full guarantees that the general interests of the community would be respected."

The French foreign affairs minister, Maurice Couve de Murville, ignored this, considering the matter to be outside the field of community policy and therefore uniquely within his government's competence. Such conflicts of opinion persist even today, for the nuclear states of Euratom regard nonproliferation policies as coming within their foreign and defense policies, and therefore no concern of the commission, which takes an opposite view.

As the American nonproliferation policy evolved, a meeting was held the following year at the U.S. embassy in London, attended by the main Western industrial powers. The objective was to secure agreement among suppliers that they would not furnish essential nuclear materials or equipment to any nonnuclear weapons state, except under guarantees of safeguarded peaceful use. The American proposal was viewed with reserve by several countries on the grounds of uncertainty concerning the Soviet attitude. France was more forthright: She refused to join a common front of export suppliers as long as she was treated, by countries such as Canada, differently from the United States and the United Kingdom over sales of uranium.

Meetings of this sort were held without success every year until 1965. They usually took one day, and the French participants used to call them "Cashmere meetings" because, after voicing their disinclination to cooperate, they would leave and go to buy Scotch pullovers. After another 10 years, the London meetings were reinstituted, in different circumstances, with Soviet participation and French goodwill. They then achieved some measure of success.

In 1963, France was at last able to obtain an objective pursued since 1956: the conclusion of a substantial contract for the purchase of nonsafeguarded uranium. Where she had failed with Canada, she succeeded with South Africa, whose mining industry was also suffering from the nonrenewal of American purchases.

When I was invited in 1963 to make a tour of the South African nuclear installations, I learned with great satisfaction that their government had decided not to discriminate between the three Western nuclear powers and was ready to authorize its uranium producers to conclude a multiannual sales contract with the Commissariat à l'Energie Atomique (CEA). The contract, signed a few months later, covered a tonnage equivalent to nearly two-thirds of the annual French production at that time, at a price of about one-fifth that quoted in a limited offer by the Belgians to the CEA in 1955 (see p. 292) and about one-third that quoted by the Canadians during the abortive 1957 negotiations. Overabundance was beginning to make itself felt.

The existence of this purchase agreement with South Africa remained secret for a long time. But it was known to the United States, who was extremely irritated over such a restriction free sale, although it was made under the same conditions as sales to themselves or to the United Kingdom. Some three years later, Washington made its displeasure felt in Pretoria by refusing until the last moment to renew the 10-year cooperation treaty under which highly enriched uranium was to be supplied for the South African national research reactor, despite the fact that the latter was of American origin and under IAEA control. Had it been necessary, France would have been prepared to find, from her military production that was just beginning in her Pierrelatte plant, the few kilograms of uranium-235 that were needed by her South African uranium suppliers for their experimental reactor. Again, 15 years later, in 1981, the same problem arose but this time Pretoria was able to start supplying the required amount of sufficiently enriched uranium from its own national isotopic separation plant.

Thus, throughout the years the American policy of international safeguards was gradually put into effect, France had tried to mitigate the effects of such a policy on her own program. Over the same period, France was also confronted by Washington's influence in the negotiations setting up the European Atomic Energy Community (Euratom). Having failed to persuade all the future members of Euratom to renounce the military option, the United States nevertheless played an important part in the organization's foundation and early operation. They had two distinct objectives: European integration, and the promotion of American-type nuclear plants, fueled with enriched uranium and subject of course, to safeguards to guarantee their peaceful utilization.

At this point, we need to go back for a moment to the European scene in 1955, to examine the origins of nuclear collaboration between the western European nations.

Potential and limitations of international safeguards

by H. Grümm*

The military attack in June last year on a research reactor under construction in Iraq once again drew the IAEA safeguards system into the public arena. Unfortunately, we found ourselves somewhat unprepared for this kind of discussion, and at a disadvantage because we had no sensational stories to tell. The debate showed *inter alia* that widespread misunderstandings exist about both the potential and the limitations of international safeguards.

In many instances, expectations of what safeguards can do are rather inflated, and confrontation with the limitations of safeguards often leads to the other extreme disappointment and harsh criticism. We have to admit that misunderstandings are, to a certain extent, engendered by the commitment of the IAEA to talk about sensitive safeguards matters only to its Board of Governors, and by our habit generally of talking only in professional language.

However important the question of communication, the issue which really matters to all of us is to have the assurance that nuclear material will be used only for peaceful purposes. In most instances the acquisition of nuclear weapons is motivated by considerations of national security or feelings of prestige. Since 1945 various policies have been tried to discourage the spread of nuclear weapons, including classifications of know-how, embargoes, political action and pressures. All these measures were unable to prevent the emergence of five nuclear-weapon states, and are doomed to fail in the long run. To give but one example: the strict security classification of the technology of uranium enrichment diffusion has been by-passed by gas centrifuges, accessible even to developing countries; in spite of strict embargoes South Africa has succeeded in producing high-enriched uranium for its research reactor, and eventually low-enriched material for its power plants. There are already many states able to produce material suitable for nuclear weapons without external support. Their number will increase yet further with time.

In spite of the rather limited success of the policies of denial, it need hardly be said that sensitive material, equipment, and know-how, should be exported only in a carefully considered manner and under strict safeguards, preferably full-scope. Clearly, however, non-proliferation is not really a technical, but a political problem. As experience has shown, among the various conceivable instruments of non-proliferation policies (e.g. denial, detente, security arrangements, assurances of supply), the most reliable barrier against proliferation is the concerted political action of states who understand that it is very much in the interests of their own security not to acquire nuclear weapons. 114 non-nuclear-weapon states have demonstrated this conviction by adhering to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Those among them having nuclear activities have agreed to safeguards with the IAEA covering all these activities. The IAEA acts thereby as an objective international auditor entrusted with the task of verifying that the states are faithfully abiding by their non-diversion commitment. This system helps dissipate international mistrust one factor which might lead countries to consider acquiring nuclear weapons.

Safeguards system is unique

Any activity in the real world has its limitations and the verification activities of the IAEA are no exception. First of all, safeguards cannot be imposed on any state certainly not by the IAEA. We should be aware that the safeguards system is unique in international relations. It is the first time in the history of our restless species that sovereign states have voluntarily agreed to the inspection of sensitive facilities by foreign nationals. It is, therefore, no surprise that even NPT states will accept inspections only under clearly stated legal and technical constraints derived from international consensus and spelled out in safeguards agreements. It is politically naive to assume that substantial changes in the basic documents affecting the rights of states would be accepted in the foreseeable future. Also, it should be understood that the effectiveness of safeguards depends to a certain extent on the co-operation of state officials and facility operators with the IAEA.

Equally, the IAEA's budget imposes limitations on the manpower and equipment resources of the Inspectorate. This year, the annual budget of US $25 million for the Safeguards Department is about the cost of a single military aircraft. In view of the firm determination of many Member States to consider only zero-real-growth IAEA budgets, no substantial increases can be expected in the near future. To develop new equipment we are, therefore, heavily dependent on the generous support programme of some Member States.

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Using modern technology and modern electronics, new high-performance instruments are being developed for safeguards work. The photograph shows one such instrument, an image intensifier which can be used to check the Cherenkov glow of spent fuel elements in storage ponds. For the development of such instruments, which started only a few years ago, the Agency is dependent on the support programmes of Member States.

Because of these limitations, we were only able to carry out about 5060 inspection man-days in 1981. That is only slightly over half the inspection activities determined under the existing agreements. Nevertheless, safeguards are now considered as an important confidence-building measure and their deterrent effect should not be underestimated*. In assessing their strictly technical limitations, it must also be remembered that the development of professional equipment specifically for safeguards purposes started only a few years ago.

The external constraints imposed on the Inspectorate are compounded by internal difficulties. Efficient management is somewhat difficult in an international environment with a high turnover of staff and in the face of a complex and novel task to be implemented at the interface between technology and politics. However, international safeguards should not be regarded as a static phenomenon; they are an evolving endeavour, only about a decade old as a profession. In this short period of time, safeguards approaches for a dozen types of nuclear facilities and for hundreds of individual facilities have been elaborated, negotiated, and implemented. In spite of the limitations discussed above, in about 3 to 4 years' time 65 to 70% of the inspection commitments could be met and high-performance equipment – the result of comprehensive support programmes – should be available. In the meantime, we try to make optimum use of our limited resources by concentrating our efforts on those parts of the fuel cycle – about 25 facilities from among the 800 under safeguards – where large amounts of sensitive nuclear material are handled in readily accessible form.

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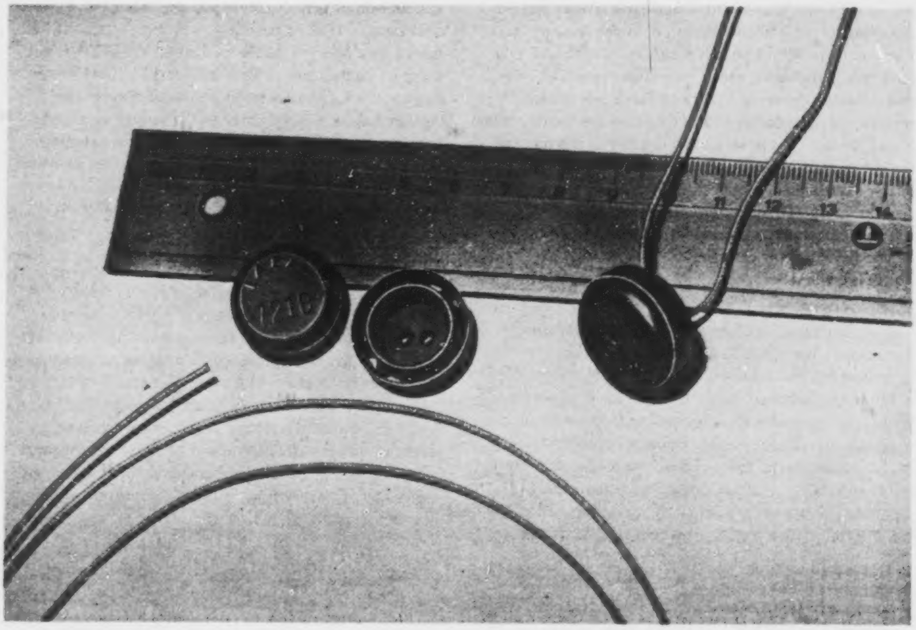
* At its 25th session, in connection with the Iraq incident, the IAEA General Conference reaffirmed "its confidence in the effectiveness of the Agency safeguards system as a reliable means of verifying peaceful use of a nuclear facility".



A seal, such as the one shown in this photograph, is a very simple but effective way of ensuring that the nuclear material stored in a container has not been tampered with since the seal was applied. These seals are inexpensive, small, and easy to apply, although they have the disadvantage that their integrity cannot be checked on the spot. Over 4000 seals were applied and subsequently verified by the Agency's safeguards inspectors in 1981.

If a comparison is made between the present safeguards system, still developing and limited by external and internal constraints, and the important role it has to play, it is understandable that real concern should be shown. However, the picture looks less gloomy if the effectiveness of the system is considered not in a purely academic way but in the light of the situation in the real world. In the first instance, it should not be forgotten that non-proliferation efforts supported by safeguards have been and continue to be successful, mainly thanks to the self-restraint and co-operation of many states. Since 1964, that is for 18 years, no new nuclear-weapon states have emerged. Only the Indian nuclear explosion eight years ago, using non-safeguarded material, has to be noted. The event has not been repeated. Moreover, the system of agreements and inspections has made the proliferation-risk areas of the world very transparent, and permits concerted deterrent action by the IAEA Member States.

Proliferation risk greatest where safeguards end

It should not be forgotten that the reports and conclusions of the IAEA are not the only source of information available to Member States. They may have their own national means for detecting unsafeguarded nuclear activities; they may take into account the internal and external stability of states, and assess their political intentions and their technological capabilities. If, for example, a country has only light-water reactors supplied from outside, it is physically unable to separate plutonium from spent fuel and to divert it. In this case, the physical impossibility provides its own assurance, in spite of the fact that at present the IAEA's Inspectorate can spend only 6 to 8 inspection-days annually at this type of facility instead of about 12 days prescribed by the model approach. This theoretical deficiency enables the Inspectorate, on the other hand, to concentrate its efforts on reprocessing plants where plutonium is being separated.

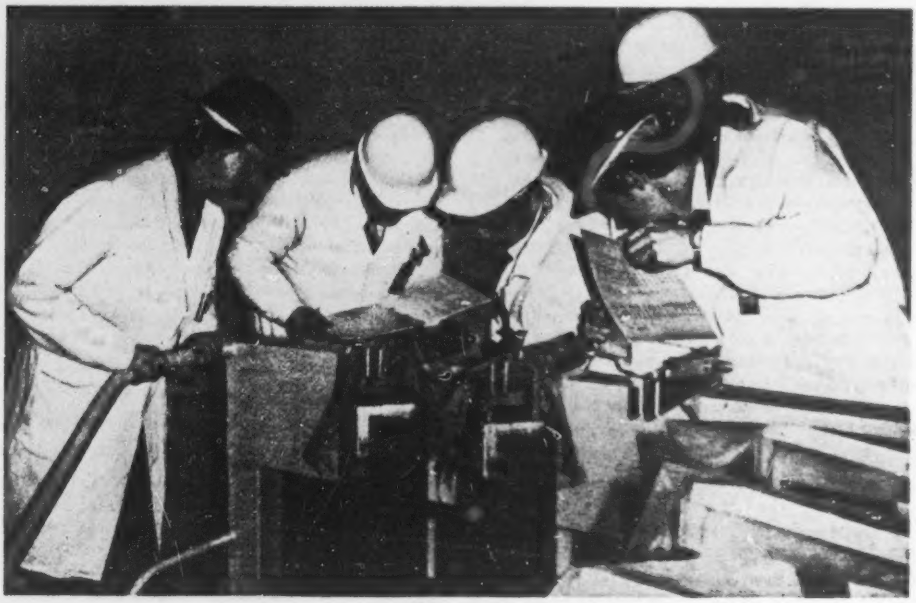
If, in the light of all the information thus at its disposal, any interested government considers the 114 non-nuclear-weapon states which are parties to the NPT, and which have thereby voluntarily agreed to submit their nuclear activities to international full-scope safeguards, it will see that 39 of these actually have significant activities, all of them under Agency safeguards. It will find that for these states, as long as there are no basic changes in international relations, incentives for diversion are limited to very few cases, if any. It will be of greater concern to the government in question to observe that not all states with nuclear activities are presently prepared to accept the NPT or any other full-scope agreement. In six non-NPT states all essential nuclear activities are, according to published information, under safeguards. These *de facto* full-scope safeguards enable the IAEA to carry out crosschecks, which facilitates the work of the Inspectorate. However, the states concerned are legally entitled – except to the extent that they are circumscribed by supply agreements – to build unsafeguarded nuclear facilities which may produce or will be able to produce weapons-usable material. Finally, the interested government in question may be seriously concerned about the fact that four states are already operating or building non-safeguarded nuclear facilities capable of producing weapons-grade material and that the available stockpile of such material may be considerable.

Thus, seen from the perspective of a well-informed government, the IAEA's safeguards system is in a somewhat peculiar situation. More than 90% of the effort of the Inspectorate is concentrated on facilities which operate in societies with a firm political commitment not to proliferate. The remaining effort is devoted to facilities in countries that have not made that commitment, and finally, the facilities representing a real proliferation risk are not accessible to inspection. Thus, the risk of proliferation is greatest where safeguards end.

It seems to be already well understood that safeguards cannot prevent the diversion of nuclear material or withdrawal by a state from a safeguards agreement. The system cannot predict future political intentions and decisions. It is an *ex post facto* warning system. It has been stated by some of the media that the IAEA is not living up to this task. This is incorrect. In its Annual Report and Safeguards Implementation Report the Agency has for years pointed to the non-safeguarded facilities operating or under construction in various countries. In September 1981, it reported to its Board of Governors that it is presently not in a position to safeguard two power reactors adequately. The international political reaction was and still is rather muted.

One of the objectives of safeguards is to deter proliferation by the risk of early detection. However, detection *per se* has only a very limited deterrent effect. Deterrence has to be provided by predictable, quick, and effective, international political reaction when the IAEA blows the whistle. Both elements, detection by the IAEA and political reaction, are necessary. It is to be doubted that the effectiveness of IAEA safeguards is really the weak link in this interaction. In any case, we in the Agency do everything to further improve the effectiveness of safeguards activities. In order to succeed, international safeguards need the continuing support of the Member States of the Agency and also the reasoned appreciation by the mass media of its proper irreplaceable role.

The IAEA's safeguards system is unique: it is the first significant attempt to combine agreements on arms control with objective and effective verification that each country is complying with the obligations stipulated in the agreements to which it is party.



Safeguards

A lawyer's view of safeguards and non-proliferation

by L.W. Herron*

Non-proliferation and proliferation are not terms which appear in the Statute of the International Atomic Energy Agency. The Agency's mandate is to deal with *peaceful uses* of atomic energy. Military uses loom behind it, however, and its regulatory objective is to ensure so far as it is able, that assistance provided by it, or at its request, or under its supervision or control, is not used in such a way as to further any military purpose [1].

When the Agency was set up in 1957 proliferation had already happened. By then the USA, the USSR and the United Kingdom had fission and fusion bombs. The Statute left their military activities outside its purview. It left aside also the military activities of other Member States, provided that they were carried on without Agency assistance and without using materials and equipment which had been submitted to Agency safeguards. France was therefore able, quite consistently with its membership obligations, to develop and deploy nuclear weapons after the establishment of the Agency. China's nuclear weapons were developed on the mainland by the People's Republic of China while the Taiwan-based Republic of China was a Member of the Agency; in any case, membership obligations *per se* would not have inhibited such activity. India's explosion in 1974, presented as a 'peaceful nuclear explosion', did not involve the use of safeguarded nuclear material.

Members of the Agency which have not submitted all of their nuclear activities to safeguards may still do legally what France and India did if they do it in the same way, without using Agency assistance to further any military purpose and without using material or equipment subject to Agency safeguards. Some few threshold states still keep the so-called 'nuclear option' open in this way. The option is not necessarily foreclosed by submitting only part of their nuclear industry to safeguards. Hence the importance of full-scope safeguards – safeguards which cover the whole of a state's nuclear activities.

It must be repeated – because it is often misapprehended – that the Agency cannot impose safeguards on a state which does not volunteer to accept them. Even when a state volunteers to accept safeguards, it may choose to volunteer only some of its nuclear activities to be safeguarded. The importance of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is that it has proved an effective political vehicle, negotiated outside the Agency, for states to undertake that Agency safeguards are to be applied to all of their nuclear activities. In the words of the NPT, Article III, the safeguards required "shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such state, under its jurisdiction or carried out under its control anywhere".

The Agency itself is not a party to the NPT and therefore cannot enforce the obligations of parties under that Treaty. Obligations owed to the Agency by NPT states arise under consequential safeguards agreements which the NPT obliges them to conclude with the Agency. It is only when such a safeguards agreement has been concluded that the question of the effectiveness of Agency safeguards can arise in the NPT context. The questions of effectiveness or ineffectiveness of Agency safeguards and the success or failure of the Agency as regards non-proliferation are therefore narrow ones, much narrower than the question of the effectiveness or ineffectiveness, success or failure of non-proliferation as a policy plank in the broad context of maintenance of international peace and security, prevention and removal of threats to the peace, and acts of agression familiar phrases to which some of us would still like to attach some meaning and importance (even within the United Nations Charter).

Non-proliferation is an unnatural beast, one which should never have needed to be conceived, which took too long in gestation, was born into an unhappy family and suffers from a chronic Oedipus complex. In point of law, non-proliferation measures should never have been necessary *if* lawyers had been quicker and more forthright in affirming the law of weaponry and the conduct of hostilities after the end of World War II, and *if* policy-makers had drawn the rational conclusions from the law. Unfortunately, we lived then – and continue to live now – in a world which is neither very legal nor very rational, a world in which the possession of enormous arsenals has developed in the face of the knowledge that their use would be not just illegal but also suicidal. Nevertheless, in the context of 'horizontal proliferation',* reiteration of the illegality of most contemplated uses of nuclear weapons can still contribute to the pejorative aspects of acquisition of nuclear weapons. Statements of the law can influence policy in the area of non-proliferation. Unfortunately such statements sit uneasily with the armaments and security policies of nuclear-weapon states.

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* This article is a personal view by Mr Herron, who is Director of the Agency's Legal Division. It is an expanded version of a paper given to the American Society of International Law in Washington DC, USA, earlier this year.

To illustrate: it is dangerously disingenuous to say, as do a number of military manuals of the laws of war, that in the absence of any customary rule of international law or international convention restricting their employment, the use of nuclear weapons is legal [2]. Such statements leave an impression that the use of nuclear weapons is generally legal. The law is otherwise, and has been explicated so by a series of eminent commentators from very early in the atomic age [3]. The use of nuclear weapons will in almost all circumstances breach customary rules of international law. These are rules of long standing, of a humanitarian nature, arising – in the words of the de Martens clause [4] – from the principles of humanity and from the dictates of public conscience. They relate to maintenance of distinctions between combatants and non-combatants and between military objectives and other targets**; prohibitions on the use of poisoned weapons; commission of crimes against humanity including genocide; protection of civilian populations; and disproportionality in self-defence. So far as recourse to the use of nuclear weapons might be legal by way of reprisal during armed conflict, one may note that proportionality is a requirement and that states which negotiated the two Protocols to the 1949 Conventions for the Protection of War Victims in Geneva agreed in 1977 that, at least for conventional armed conflict, reprisals should be prohibited except, in effect, against military personnel [6a]. As has been noted, the Protocols were negotiated on the basis that they did not apply to nuclear weapons, and some nuclear-weapon states entered disclaimers to this effect on signature [6b]. Nevertheless, the Protocols are not without effect on customary law and it is clear that any such effect cannot have been to weaken the customary law as it applies to nuclear weapons. At least this much can also be said for the effect of the Bacteriological (Biological) and Toxin Weapons Convention [7]*. Before leaving this digression into the illegality of nuclear weapons, it may be noted that so far as the practice of states supported by *opinio juris* may be evidenced by debates in the Security Council and the General Assembly of the United Nations, the records of discussions in those Chambers on the Israeli raid on the Tuwaitha Nuclear Centre in Iraq are entirely negative concerning self-defence by means of pre-emptive strike [8].

It would have been necessary to invent the Agency in any case, even if after World War II lawyers and policy-makers had persuaded the authorities possessing nuclear capabilities to renounce nuclear weaponry. The technology is too fascinating to technologists and the power is too seductive to power-mongers to allow confidence that the genie would be left in the bottle without some supervisory mechanism to interdict the development of weapons. The failure of the Baruch plan and the counter-plan put forward by the Soviet Union in 1946 may yet prove to be the single most critical, if not fatal, disarmament failure. Both would have effected unilateral nuclear disarmament by the United States, then the only nuclear power, and would have instituted continuing strictures on proliferation, albeit with very different systems for ensuring that no one else got the bomb. With this signal failure, 'vertical proliferation'** has run riot and 'horizontal proliferation' has come to an uneasy halt sustained in part by Agency safeguards.

Agency safeguards are only the technical means for verifying that those who say that they will not develop nuclear weapons do not do so. The Agency administers safeguards where it is requested to do so in order to verify that nuclear material subject to safeguards is not diverted to further any military purpose, to nuclear weapons or other nuclear explosive devices. The aim is to deter the production of nuclear explosives using safeguarded material through the fear of detection and of the detriments and penalties that would follow. It would be unrealistic and quite impracticable to have a regulatory system which would achieve 100% certainty of detection. Fortunately a significant deterrent effect can be achieved with substantially less than perfect detection.

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* Horizontal proliferation refers to an increase in the number of countries which possess nuclear weapons.

** Non-discriminatory effects are adverted to in the Preamble to the Tlatelolco Treaty [5]:

> "That Nuclear Weapons, whose terrible effects are suffered, indiscriminately, by military forces and civilian population alike, constitute, through the persistence of the radioactivity they release, an attack on the integrity of the human species and ultimately may even render the whole earth uninhabitable."

In the light of current events, a re-reading of the Tlatelolco Treaty, including particulary the Preamble and Protocols, is salutary.

* Meyrowitz (Ref. [3], p.75) appears to go too far in regarding nuclear weapons as illegal by analogy with bacteriological weapons, because of their macrobiological effects.

** Vertical proliferation refers to an increase in the number and/or technological sophistication of nuclear weapons held by a country which already possesses nuclear weapons.

This, I suggest, is the real test of the safeguards system: not whether some ambitious analytical concept of timely detection can be achieved 100%, but whether the risk and consequences of being detected make it politically unacceptable to attempt diversion of safeguarded nuclear material to non-peaceful use. To date the system has passed this test.

More difficult to demonstrate – but perhaps of even greater importance than the deterrent effect – is the positive assurance, given by verification findings that material is *not* being diverted, that results from safeguards. At least among countries which have all of their nuclear activities under safeguards, this heightened assurance that legal obligations undertaken in good faith are being dutifully honoured contributes significantly to the lessening of neighbourly and regional tensions, obviating perceptions of threats to security which might otherwise be sufficient to motivate acquisition of nuclear weapons.

Has the Agency nevertheless to any extent been deluding itself as to the effectiveness of safeguards? Some of its critics would say so. I have no competence to deal with technical criticisms concerning the details of the system, and I do not propose to try to deal with them. I can say, however, that I have seen the results of the Agency's self-examination in response to the criticisms made since the Israeli attack on the Tuwaitha Research Centre in Iraq. It appears that where the criticisms have had some merit, they still did not invalidate the system as a whole. In many cases steps had already been taken to rectify the indicated deficiencies. In the remaining cases, steps to rectify them were subsequently taken or are yet in progress.

In the legal area, I should comment on some points which have been the focus of concern.

Adequacy of agreements

Safeguards agreements in connection with the NPT follow a standard format which was developed by experts from many countries and endorsed by the Board of Governors of the IAEA in February 1972. The format shows the benefits of over ten years' operation of the Agency's existing safeguards system, is a very comprehensive agreement of over 100 articles, is supplemented by *subsidiary arrangements* and *facility attachments* negotiated for individual facilities, and has stood the test of time very well. No major controversy has arisen in its implementation or interpretation, although the marriage of IAEA safeguards with those of Euratom* when the Euratom non-nuclear-weapon states undertook NPT safeguards was difficult to consummate. The difficulties, which extended to the parallel negotiations with Japan, are now largely behind us, and there are no pressures either within the Secretariat or among Member States for review of NPT safeguards agreements.

Extensive development work is needed, however – and is proceeding – on effective procedures for safeguarding material in large bulk-flow facilities, essentially enrichment and reprocessing plants. These procedures, once designed by the technicians – with policy inputs to accommodate national and international concerns – will be given legal force in facility attachments foreseen by the existing agreements. I am not so confident that policy-makers or technicians are giving sufficient attention to safeguards aspects of the emergent technology of laser-stripping. This has significant potential, apparently, for back-room enrichment and reprocessing, and may give new importance to large stocks of depleted uranium which are held mainly in nuclear-weapon states, where they are not at present designated for Agency inspection.

Safeguards agreements with states not party to NPT or the Tlatelolco Treaty [5] do not rest on such an elegant and comprehensive foundation as the NPT ones. Instead, they are based mainly on a set of policy guidelines called the Agency's Safeguards System, printed in Agency document INFCIRC/66 [9]. The latest revision of this document is now fourteen years old. INFCIRC/66 itself is certainly deficient and there are some earlier agreements based on it which are somewhat skeletal compared with more recent agreements. These later agreements spell out more fully a number of the undertakings and procedures in accordance with positions taken by the Board of Governors and progressively added into agreements. The latter-day accretions reflect technological developments in safeguarding, the efforts of the Secretariat even before supplier states joined in developing stricter export conditions, and the more rigorous requirements of supplier states, particularly those communicated to the Agency in the so-called London Club or Nuclear Suppliers Group guidelines [10].

It would certainly be more comfortable for the Secretariat to enter negotiations for new INFCIRC/66 agreements on the basis of an up-to-date revision of the document approved by the Board of Governors. The Director General aired the possibility of a review of the INFCIRC/66 system at the February 1982 meeting of the Board of Governors, but even so, responses from members of the Board might not eventuate for some time. In the meantime, the Board's expectations as to the content of INFCIRC/66 agreements are well known. The Director General would not recommend to the Board a new agreement which did not contain provisions additional to those expressly foreseen by INFCIRC/66 covering, for example, exclusion of nuclear explosive uses of safeguarded nuclear material; provision for containment and surveillance techniques; requirements for subsidiary arrangements; clear requirements for safeguards on subsequent generations of nuclear material; coverage of technology transfer and of heavy water; and on-going safeguards requirements in respect of previously safeguarded items, fuel and produced material, even after the termination of the safeguards agreement. While lack of these is now seen as a deficiency of the original policy document, they are not lacking in the Agency's safeguards system as it is now implemented.

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* European Atomic Energy Community.

Access for inspections

The Agency is not a police force, nor is a safeguards inspector a policeman with an open search-warrant. A popular conception of a safeguards inspector's role seems to be that he should be able to descend on a facility out of the blue and at a moment's notice so as to be able to catch state authorities red-handed as they attempt to take away casks full of weapon-grade nuclear material for making nuclear weapons. The inspector's task is not so dramatic. It is, rather, to make sufficiently frequent and timely inspections of nuclear materials and facilities to be able to conclude that there has been no diversion of nuclear material, or if he should not be able to come to this conclusion, to report accordingly to the Member States through the Director General and the Board of Governors. As the basis for his conclusions he will check that the state's reports on its nuclear activities are consistent with the facility operators' records; he will check the location, identity, quantity, and composition of nuclear material subject to safeguards, and the information on the possible causes of accounting discrepancies concerning material, shipments, and inventories. Formulae have been established to give objective values to frequency and timeliness of routine inspections in regard to the whole range of types of facilities and the attractiveness for diversion to weapons purposes of all nuclear materials subject to safeguards.

Concern has been expressed from time to time about periods of advance notice that the Agency is required to give to a state before an inspector can have access to a facility or material for inspection purposes. Opinions may differ concerning the generosity with which the Agency in practice gives advance notice in excess of periods provided for by agreements, but the legal prescriptions appear to strike a reasonable balance between ideal inspection needs on the Agency's side, and the legitimate self-interest of states in minimizing inconvenience and undue interference in plant operation. Under NPT safeguards agreements the requirement of advance notice for routine inspections is only 24 hours in the case of such sensitive facilities as those which contain plutonium or uranium enriched to more than 5%. For special inspections (where the Agency considers that information obtained from the state is inadequate for the Agency to fulfil its responsibilities under the agreement), the requirement is that access be given "as promptly as possible" after requisite consultations between the Agency and the state [11a]. Under non-NPT safeguards agreements a more generous period of advance notice, namely one week, applies for routine inspections, while a period of 24 hours applies to special inspections. This apparent generosity is considerably diminished, however, by the provision that when the Agency has the right of access to a facility at all times – as it does for example, under INFCIRC/66 agreements, to larger reactors and all but the smallest enrichment, reprocessing and fuel fabrication plants – this requirement of one week's advance notice does not apply. Indeed, some facilities are already continuously inspected. Since the availability of inspectors is not unlimited, and since for other than European destinations travel times approaching or exceeding 24 hours may be involved, the legal rights of the Agency concerning notice of inspection would not appear to be unduly restrictive or to be prejudicial to the attainment of the Agency's safeguard objectives.*

Undeclared material and facilities

The Agency is not an intelligence agency in any popular conception of the term. It certainly has no mandate to engage in clandestine intelligence gathering in Member States. It does, however, have rights to gather and analyse information in the limited areas defined by safeguards agreements; it can expect that the information provided by the state will be relevant and adequate for the Agency's purposes, and it has a right to seek further information if this is not the case.

There is a view that the Agency has no rights in respect of nuclear material or facilities which have not been declared to it. In my view this is not the legal position under NPT safeguards agreements, and even under INFCIRC/66 (non-NPT) agreements it may need some qualification. Under NPT safeguards agreements the rights and obligations of the state and the Agency are such that if the Agency is not satisfied that all facilities and nuclear material have been declared to it by the state according to the agreement, then the Director General may report the matter to the Board of Governors. The Board may then decide on measures to ensure "verification that nuclear material is not diverted" [11b]. This is the case in respect of facilities even before they contain nuclear material, notwithstanding that NPT safeguards are focused on the safeguarding of nuclear material. As regards nuclear material itself, NPT safeguards agreements do not require the state to report to the Agency indigenously-produced source material at the mining and initial processing stages. In practice, such material while it remains in the producing state must be reported only when it becomes either uranium hexafluoride or uranium metal [11c]. Indigenously-produced uranium oxide (yellow-cake) may therefore be present legally in a state without the knowledge of the Agency. The position is different if the same material is imported from another state, since in this case — and also when such material is exported — it must be reported to the Agency, which will have the opportunity to check its quantity and composition. There appeared to be little enthusiasm at the last meeting of the Agency's Board of Governors for a suggestion by the Director General that yellow-cake might be made subject to more extensive safeguards procedures.

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* To whatever extent the Agency has rights to make unannounced visits to facilities, it has so far not used them. Visa requirements and other travel arrangements can detract from the exercise of such rights, except where inspectors are already in the country (Canada and Japan). A more practical consideration is that for more important facilities, visits will not be productive unless sensitive parts are accessible. Thus, a visit without advance notice to check the content of the pressure vessel of a power reactor would be without object unless it were known that the reactor would be closed down and the core exposed.

If the Agency has reason to believe that nuclear material required to be reported by a state has not been reported, it cannot send its inspectors on searching missions. However, it can put questions to the state and it has the possibility, through special inspections which it may request, of gaining access to locations other than the specified strategic points to which it has access during routine inspections. If special circumstances calling for special inspections arose, the restrictions on access associated with routine inspections would be displaced.

Under INFCIRC/66 agreements the position is likely to be less clear concerning the Agency's rights in regard to undeclared facilities and nuclear material. This follows from the selective coverage of such agreements under which only specified material, specified facilities and nuclear material produced therewith are submitted to safeguards. Furthermore, facilities may come under safeguards only temporarily while safeguarded nuclear material or heavy water is present in them. More recent agreements would also bring under safeguards facilities established by the use of identified information transferred from a third state. So far the Agency and states concerned have no experience in the implementation of relevant replication clauses and it may be problematic in some cases whether, as a matter of evidence, new facilities have been established using transferred technology. The Agency therefore seeks to incorporate into agreements dealing with technology transfer a 'deeming' clause designed to obviate the need for evidentiary proof that a facility uses transferred technology. Such clauses negotiated to date are of a limited duration, usually 20 years, and do not solve the problem of evidence for the long term.

INFCIRC/66 agreements have mainly been concluded at the behest of supplier states which have made it a condition of supply of facilities, equipment, materials or technology, that they be subject to Agency safeguards. In some cases the supplier state is itself a party to the agreement and may join in making notifications under it. This gives formal expression to the on-going interest of the supplier state in ensuring that the nuclear capacity of the recipient state — which it has been instrumental in developing — remains peaceful. Whether or not this aspect of policy finds formal expression in safeguards agreements, support by supplier states for the Agency's efforts to negotiate and implement the best possible safeguards agreements is vital. It would be naïve for a supplier state to think that it could abdicate all responsibility for its contribution to the nuclear capability of another state merely by requesting that Agency safeguards apply. The Agency needs to have the active support of supplier states, indeed of the whole international community, not only when negotiating the agreement but also throughout its implementation.

Timely warning

Concern has been expressed that the Agency would not be able to give 'timely warning' to the international community of diversion of safeguarded nuclear material [12]. Timeliness is certainly a desirable element in safeguards, both as a basis of quantifiable objectives in a goal-directed technical safeguards system* and, at the political level, as a basis of the credibility of verification of non-diversion: if such verification is to be credible, safeguards must be able to detect a diversion and sound the alarm reasonably promptly. Consequently, the Agency attempts to achieve compatability between the time needed to detect a diversion ('detection time') and the time needed to convert diverted material into a weapon ('conversion time'). For abrupt diversion of plutonium and highly enriched uranium, however, the conversion time could be so short as to make it virtually impossible for the detection time to match it. Only real-time reporting and analysis could confidently do this, but such methods do not yet exist.

The hard fact is, therefore, that 'timely warning' would in some cases not be achievable if 'timely' in this sense means providing sufficient time for other states to intervene diplomatically to dissuade the diverter from making or using a nuclear weapon.

It is a misconception, however, that it is a prescribed task of the Agency to deliver 'timely warning'. This is not the task under NPT safeguards, where the emphasis rests on assurance of non-diversion. It would be wrong to criticize the Agency for not being able to achieve timely warning when this was already recognized as unrealistic and was not imposed on the Agency as a requirement of its safeguards system.

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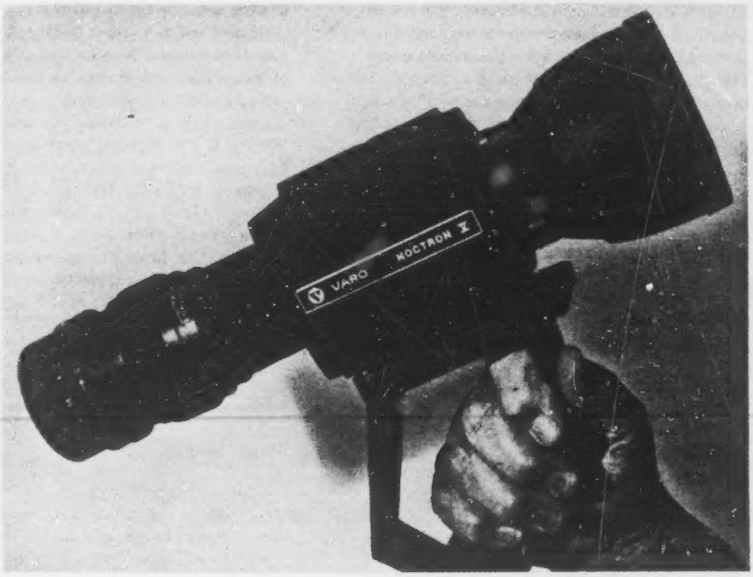
* INFCIRC/153, Part II [11] spells out the objective of safeguards as "the timely detection of diversion of significant quantities of nuclear materials".



Agency safeguards are the technical means for verifying that those who say they will not make nuclear weapons do not do so, and this Cherenkov viewing device is one of the instruments the Agency has at its disposal. But the question of the effectiveness or ineffectiveness of Agency safeguards is a narrow one, much narrower than the question of the success or failure of non-proliferation.

Notwithstanding that timely warning as such is not strictly a requirement, the safeguards system – in cases other than those of abrupt diversion of directly usable weapons material – does seek to achieve comparability of detection and conversion times. When these are comparable, the timeliness with which the international community can be informed so as to dissuade the diverter from further unacceptable action will depend on the speed of procedures provided for reporting the conclusions drawn from inspection activities.

The legal basis does exist for prompt reporting of diversion, or inability to verify non-diversion, to be given by the Agency once detected. The legal basis is designed to obviate political factors which otherwise might operate within the Agency to delay the establishment of conclusions about inspection activities. Inspections and the analysis of inspection results are designed as technical professional operations using objective criteria wherever possible, and a finding by an inspector of non-compliance with an agreement would be the end-result of this technical process. An inspector who concludes that there has been a non-compliance – or that he is unable to verify that there has been no diversion – has no discretion whether he will take the matter further: he is obliged to report it to the Director General who, in turn, has no option but to transmit the report to the Board of Governors. One would expect that neither an inspector nor the Director General would want to carry alone for very long the awesome responsibility of the knowledge of a non-compliance. The responsibility would therefore be transferred to the Board of Governors with all haste.

The Board is required by its own rules to be so organized as to enable it to function continuously; and members of the Board "should be prepared, at short notice, to attend meetings of the Board". The convening of meetings of the Board does not depend on any one person. Rather, meetings can be requested by the Chairman of the Board, any member of the Board, or the Director General. Also – importantly – they can be requested by any Member State of the Agency to consider any matter of an urgent character arising out of Article XII.A.6 of the Statute which that Member State wishes to bring to the attention of the Board [13]. Thus, any Member State of the Agency can have the Board convened to consider a question of non-compliance with safeguards obligations.

The Board itself is a political body with all the consequent advantages and disadvantages, but its substantive options for invoking sanctions are also laid out closely in Article XII.C of the Statute and are included in all Agency safeguards agreements. To invoke sanctions in cases of non-compliance, the Board shall call upon the state concerned to remedy any non-compliance which the Board determines to have occurred, and may report the non-compliance to all Member States of the Agency, to the Security Council, and to the General Assembly of the United Nations. This procedure first ensures maximum publicity and, second, removes the matter to those United Nations bodies primarily responsible for matters affecting international peace and security.

Coercive measures

As may have emerged from the immediately preceding discussion, it was never intended that the Agency should administer political or coercive sanctions to a state breaching safeguards agreement obligations. The main coercive measure at the Agency's disposal is publicity in a case of non-compliance*. After that, coercive action is in the hands of the Security Council and General Assembly of the United Nations which have open to them sanctions under the Charter. No doubt political and diplomatic pressures would also be brought to bear bilaterally by other states, either acting alone or in concert. The speed, severity, and effectiveness of such coercive action is not within the control of the Agency.

Politicization

In the somewhat heightened atmosphere of the last twelve months, fears have been expressed that the Agency is becoming politicized and that politicization might undermine the capacity of the Agency to perform its regulatory functions. Signs of growing politicization were seen, especially in the resolution passed by the General Conference in September 1981, suspending immediately the provision of any technical assistance to Israel under the Agency's Technical Co-operation programme. The resolution envisages further measures if Israel does not accept safeguards on all of its nuclear activities [14]. It seems questionable in this regard whether there is increasing politicization of the Agency and whether there is any significant threat to the Agency's viability. Despite having technical functions to perform, the Agency, being an intergovernmental organization, is inevitably political in some of its aspects. The designation of Egypt in 1977 to the seat until then occupied by South Africa, as the country in Africa most advanced in the technology of atomic energy, was political, as was the rejection of the credentials of the South African delegation to the General Conference in 1979. There was a long political transaction leading up to the expulsion from the Agency of representatives of the Republic of China in 1971. Amendments to Article VI of the Statute in 1963 and 1973 effecting increases in the size of the Board of Governors could be characterized as political in the same way in which present attempts at increasing the size of the Board are characterized. All of these events have gone on inside and outside of the policy-making organs of the Agency, namely the Board of Governors and the General Conference, without having significant effect on the performance of the Agency's technical functions. So far, indications within the Secretariat are that the events of the past year have heightened the consciousness of the importance of the Agency's functions, and have caused a critical examination of objectives and means to their attainment which can only be beneficial.

References

[1] IAEA Statute, Article II.

[2] *United States Army Field Manual* FM-27-10 "The law of land warfare" (1956); *Law of Naval Warfare* NWIP 10-2 (1955); AFP 110-31; *International law – the conduct of armed conflict and air operations* (1976); *Manual of Military Law*, Part III "The law of war on land" United Kingdom (1958).

[3] e.g. **J.M. Spaight** *Air Power and War Rights* (1947) 276; see also **G. Schwarzenberger** *The Legality of Nuclear Weapons* London (1958), and references at p.3, footnote 1 thereof, to commentators asserting both the illegality of nuclear weapons and those asserting with qualifications the legality of nuclear weapons; **I. Brownlie** *Some legal aspects of the use of nuclear weapons* ICLQ, Vol 14 (1965) 437; more recently, **E.L. Meyrowitz** *The status of nuclear weapons under international law* Guild Practitioner, Vol 38 (1981) 65; for a sustained attempt to defend legality of use of nuclear weapons, **Captain F. Bright, Jr** *Nuclear weapons as a lawful means of warfare* 30 Military Law Review, p.1.

[4] *Fourth Hague Convention of 1907*, Preamble.

[5] The Treaty for the Prohibition of Nuclear Weapons in Latin America.

[6a,b] **G.H. Aldrich** *New life for the laws of war* 75 American Journal of International Law (1981) 764; 781.

[7] Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (Washington, London, and Moscow, 10 April 1972).

[8] United Nations General Assembly, A/36/PV.52–56, Security Council, S/PV.2280–2288.

[9] INFCIRC/66/Rev.2 *The Agency's safeguards system* (1965, as provisionally extended in 1966 and 1968).

[10] INFCIRC/254 and Adds. *Communications received from certain states regarding guidelines for the export of nuclear material, equipment and technology.*

[11a,b,c] INFCIRC/153 (corrected) *The structure and content of agreements between the Agency and states required in connection with the Treaty on the non-proliferation of nuclear weapons* paragraphs 83(b); 18; 34.

[12] **Senator A. Cranston** *Opening statement to US Senate Foreign Relations Committee on IAEA* (2 December), for example.

[13] Provisional rules of procedure of the Board of Governors, Rule 11.

[14] IAEA document GC(XXV)/RES/381.

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* The Agency may also curtail or suspend its technical assistance. Since the Agency has not developed its statutory role as a supplier of materials and equipment to states, the sanction of calling for the return of materials and equipment it has made available to a State is hardly meaningful in the context of non-compliance with safeguards obligations.

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IAEA SAFEGUARDS IN 1981

Vienna, 14 June 1982 - General The sixth Safeguards Implementation Report (SIR) covering the application of the International Atomic Energy Agency (IAEA) safeguards during 1981 was submitted to the June session of the IAEA Board of Governors.

The IAEA Safeguards System is designed to verify that no diversion of safeguarded nuclear material is taking place and that safeguarded nuclear plants are not used to further any military purpose. The system is an essential part of the larger international effort to prevent the proliferation of nuclear weapons. It should be remembered that the system is limited to the verification of the safeguarded nuclear activities of the states concerned and is based on agreements with them.

The number of states technically capable of producing nuclear material suitable for nuclear weapons is already large and likely to increase. Up to now 114 non-nuclear-weapon States have adhered to the Non-Proliferation Treaty (NPT) and thus entered into a legal commitment under international treaty not to acquire nuclear weapons or other nuclear explosive devices in any manner whatsoever. 37 of these states have substantial nuclear activities. 36 of them have concluded the required safeguards agreement with the IAEA, and one agreement is pending. 22 Latin American States have also ratified and brought into force the treaty for the Prohibition of Nuclear Arms in Latin America. All but 2 of these States are also parties to the NPT.

There are in addition, 12 non-nuclear-weapon States not Party to the NPT operating nuclear facilities. In 8 of these States all substantial activities known to the Agency (from published information) are covered by provision of existing IAEA safeguards agreements, while in four, unsafeguarded nuclear facilities which are able to produce weapons usable material are operating or under construction. Nevertheless, approximately 98% of the nuclear activities in all non-nuclear-weapon States both party and non-party to the NPT, are presently under safeguards. For the first time the SIR also reports on the IAEA's experience in applying safeguards on some peaceful activities in nuclear-weapon States.

Principal conclusion for 1981

The basic conclusion of the SIR for 1981 is that the Secretariat did not detect any anomaly which would indicate the diversion of a significant amount of safeguarded nuclear material - or misuse of facilities or equipment subject to safeguards under certain agreements - for the

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manufacture of any nuclear weapon, or to further any other military purpose, or for the manufacture of any other nuclear explosive device. However, in the case of two nuclear power plants in non-nuclear-weapon States the Agency was not in a position to perform adequate verification pending implementation of certain technical measures. In one of these cases the discussions on the requisite measures are proceeding satisfactorily. While no conclusion could be reached in the two cases in question until the requisite technical measures are taken the Secretariat found it reasonable, with this qualification, to conclude that the nuclear material under IAEA safeguards in 1981 remained in peaceful nuclear activities or was otherwise adequately accounted for.

Facts and Figures

The SIR provides statistics and a factual account of the IAEA's safeguards operations during 1981, it identifies areas where progress has been made and indicates further improvements that are required. It constitutes thus an instrument of systematic and critical scrutiny of safeguards implementation.

By the end of 1981, 844 installations were covered by safeguards in non-nuclear-weapon States. Nuclear material under safeguards amounted to 5 tons of separated Plutonium, 10 tons of highly enriched uranium, 71 tons of Plutonium contained in irradiated fuel and 37 642 tons of low enriched uranium and source material.

In 1981 the IAEA spent nearly US$ 20 million on safeguards. More than 1400 inspections were carried out at about 500 major nuclear installations in 50 States involving over 5000 man-days of inspection. About eight million surveillance pictures were taken by about 160 surveillance systems and evaluated. More than 4000 seals were applied and subsequently verified. The Safeguards Analytical Laboratory analysed nearly 900 samples of nuclear material collected at facilities. Accounting reports concerning about 700 installations were received. An additional 345 000 data entries were processed and stored in the Agency's computer.

Progress during 1981

The Secretariat had considerable progress to report. Inspection effort increased significantly and so did the attainment of safeguards goals.

Required improvements

The SIR also points to a number of areas where further improvements are necessary. This is not surprising since safeguards is an evolutionary technology and the numbers and complexity of nuclear plants under safeguards are continuing to increase. Among the main problems are the limited manpower of the inspectorate, availability of suitable instruments and restrictions placed by some States on the acceptance of IAEA inspectors.

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In 1981 the staff of regular inspectors, i.e. experienced inspectors who were designated to specific States increased by 25%.

This enabled the Secretariat to increase considerably inspection effort at facilities. However, substantial efforts are still necessary in recruiting and training additional inspectors to narrow the gap between the inspection effort required and available manpower.

Another problem is instrument availability. Special equipment has to be developed for safeguards purposes: automatic surveillance cameras and TV systems, tamper-resistant seals, non-destructive measurement instruments, etc. Several Member States have launched comprehensive support programmes to complement the IAEA's efforts. In 1981, various new instruments developed in these programmes have been tested and some have been introduced into regular service.

In general co-operation between the IAEA and States having safeguarded nuclear activities was smooth and satisfactory; however, substantial difficulties persist in securing the consent of some States to the designation of new inspectors. These difficulties effect the efficiency of safeguards to some extent. They do not yet impair their overall effectiveness but could develop into a major problem if entire categories of inspectors were rejected, for instance, because of their nationality or language qualifications.

Measures foreseen

As part of the 1983 budget the Director General has submitted proposals to the Board of Governors to overcome, in particular, the manpower gap. These proposals involve a further increase in the inspectorate for 1983 and the years to come and some modification of the internal organization of the Safeguards Department. They also foresee the use of qualified supporting staff to participate in inspections and a special training program for nationals from developing countries.

During the next five years nearly US$ 20 million is expected to be required for safeguards equipment. The support programmes by Australia, Canada, the Federal Republic of Germany, Japan, the United Kingdom and the United States and assistance by additional States have helped considerably in developing and testing new equipment.

Publication of Safeguards Information

The IAEA's two safeguards systems require the IAEA to take every precaution to protect commercial, industrial or confidential information it acquires in applying safeguards and also lay down strict rules about the publication of such information. This reflects the concern of member states to ensure that their national and commercial interests are not damaged by the leakage of proprietary or other valuable information about their competitive nuclear industries. The IAEA is, of course, aware of increasing public interest in the effectiveness of the safeguards operation and after a preliminary discussion, the Board of Governors decided to examine this question in detail at its meeting in February 1983.

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INTERNATIONAL ATOMIC ENERGY AGENCY

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HISTORICAL OVERVIEW OF INTERNATIONAL SAFEGUARDS

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HISTORICAL OVERVIEW OF INTERNATIONAL SAFEGUARDS

The belief that the avoidance of proliferation is too vital to depend exclusively on unverified national undertakings has led to the development of IAEA safeguards, a unique system for the verification of peaceful use commitments through on-site inspections by international civil servants.

The safeguards system has its origin in the Atoms for Peace proposal of 1953, which abandoned the earlier concept of international ownership of sensitive nuclear installations in favor of international inspection of natonal activities. The first step was adoption of the IAEA Statute, which authorizes the agency to apply safeguards to its own projects and to other activities at the request of the parties involved.

The adoption of the Statute was followed by the development, on an evolutionary basis, of more detailed procedures applicable to a variety of different types of nuclear activities. This system, INFCIRC 66, was completed by 1966. The basic approach adopted was a graduated system of reporting and inspection, emphasizing materials accountancy, designed to detect diversion of nuclear materials to unauthorized use.

The Nonproliferation Treaty placed on the Agency the important new responsibility of applying safeguards to the entire peaceful nuclear programs of treaty parties. This necessitated the development of a modified safeguards system, INFCIRC 153, introducing several new concepts, including at "strategic points" and greater emphasis on instruments, and containment and surveillance. Implementation of the system has proceeded rapidly with a total of 416 installations in 51 countries now subject to the Agency's safeguards.

The development of improved safeguards techniques, especially for the difficult case and bulk handling facilities, such as reprocessing plants, is proceeding. In addition, implementation of the Agency's statutory authority to store surplus plutonium is under consideration.

While safeguards have proven to be technically demanding, their widespread acceptance and generally favorable results have justified the reliance placed on them in allowing peaceful uses of nuclear energy without unacceptable risks of proliferation.

INTRODUCTION

Few issues of our times have aroused such widespread and deep concern as has the proliferation of nuclear weapons. The issue of proliferation is compounded by the ironic fact that many of the same materials and basic processes that are essential to the fashioning of nuclear explosives are also the key to the peaceful uses of nuclear energy, a new energy source every bit as revolutionary in increasing man's capacity for creation as are nuclear weapons in increasing his capacity for destruction. It is not surprising, therefore, that unique arrangements and mechanisms have been developed in an effort to reduce the likelihood of proliferation, while preserving the opportunity to benefit from the peaceful uses of the same basic force.

To deal with the seeming dilemma of how to share the benefits of the peaceful uses of nuclear energy widely without contributing to the risk of proliferation, the international community has developed a mechanism which includes two mutually reinforcing elements.

- A pledge by nations undertaking peaceful nuclear activities that these activities would not be misdirected. These pledges may be given either in bilateral or multilateral form, and they may apply to all, or only to designated parts, of a states nuclear activities. The Nonproliferation Treaty (NPT), now adhered to by 117 states, is the most prominent vehicle for peaceful use pledges, but bilateral and regional undertakings, in particular the Treaty of Tlatelolco, are also of major importance.
- The verification of compliance with these pledges through a system of objective technical measures, including inspection, applied by international civil servants, and designated "safeguards."

A perspective of how and where safeguards fit in the broader nonproliferation regime of which they are a part is vital to any realistic assessment of their role:

- Safeguards are not the primary means of discouraging acquisition of nuclear weapons, since they are applicable only to nations which voluntarily pledge that particular nuclear activities will not be employed for nuclear explosives; yet, safeguards can be an important collateral means of discouragement, both by providing an obstacle to development on the part of states whose initial intentions may have changed and by minimizing the risk of competitive nuclear weapons developments by potential adversaries.

- Safeguards are not a means for prohibiting violations of peaceful use undertakings, since they constitute only a system of verification; yet they may strongly deter such violations by triggering appropriate responses which would follow such a grave breach of an international obligation.
- Safeguards do not provide for the search for facilities or activities which have not been declared, even when a state is under an obligation to place these under safeguards; yet, safeguards might well lead to identification of such facilities, through material flows or other links between declared and undeclared facilities.
- Safeguards do not function directly to prevent the risk of theft or diversion of nuclear materials by subnational elements, since this is the responsibility of states acting in their own self interest. Yet, they may be of substantial help to a state in detecting such diversion.

In summary, international safeguards are a single element, albeit a very important one, in the overall nonproliferation regime.

In recounting the progress that has been made in the development of safeguards as well as the problems that remain, it is well to bear in mind that safeguards represent a fundamental departure in the way in which nations have sought to ensure that international undertakings are fulfilled. For the first time, sovereign nations have agreed that compliance with their solemn assurance should be subject to verification by an international inspection force with broad rights of access and inquiry. Measured against the historic pace by which fundamentally new institutions evolve, the progress in safeguards has been impressive.

EARLY DEVELOPMENTS

The history of safeguards begins with the earliest post-war efforts to control nuclear energy and avoid its further use for military puposes. While recognizing the essential role of inspection in any system of international control, the Acheson-Lilienthal report of 1946 concluded that inspection alone would be inadequate to assure the detection and prevention of violations, and that "dangerous" nuclear activities should, therefore, be conducted exclusively by a global atomic development authority which would own and operate all facilities of a sensitive nature.

Although this conclusion is still sometimes cited by critics of the current nonproliferation regime, careful reading of the Acheson-Lilienthal report suggests that a major concern of its authors was the difficulty which they believed would be encountered by an inspection system in detecting clandestine, or undeclared, nuclear activities. Such detection is not a function of the current IAEA safeguards system.

The failure of the early effort to reach agreement on control of nuclear energy was followed by a period during which secrecy was maintained on virtually all nuclear information. This approach proved unsuccessful in avoiding the spread of nuclear weapons.

In December 1953, in a major speech before the United Nations, President Dwight Eisenhower proposed a new approach to the issue of nuclear control designed to avoid the objections to an international monopoly of nuclear development. A major thrust of the proposal was to replace secrecy with a deliberate program of international cooperation in peaceful uses to be conducted under the auspices of an International Atomic Energy Agency, which would receive and distribute the stocks of nuclear material made available to it for peaceful purposes under appropriate safeguards.

The Atoms-for-Peace proposal met with an enthusiastic reception both in the U.S. and abroad, with several important consequences, including new domestic legislation where necessary, which encouraged domestic peaceful nuclear activities and international nuclear cooperation.

Of the greatest importance from the standpoint of international safeguards, however, was the initiation in early 1956, of negotiations for the creation of the International Atomic Energy Agency. These negotiations culminated in agreement on a statute for the new body in October 1956, a schedule which seems remarkable in light of current practices. Article III.5 of this statute authorized the Agency to apply safeguards under Agency project agreements, when it acted as the supplier of assistance made available by a member state; when requested by the parties to a bilateral or multilateral agreement; or when requested by a party unilterally to apply safeguards to any of its nuclear activities.

There is nothing in the Agency Statute which obligates a Member State to accept safeguards on all or on any part of its nuclear activities; nor obliges supplying Members to require IAEA safeguards on assistance which they supply bilaterally. In practice, however, several suppliers, made the acceptance of safeguards a condition of their nuclear cooperation arrangements, thus giving a vital early impetus to the development of safeguards.

There was, however, a complication. Upon its creation in December 1957, and for some time thereafter, the Agency was not yet in a position to apply the safeguards which its Statute authorized. To avoid this delaying the initiation of cooperation, the early bilateral agreements of some suppliers provided for the application of safeguards on a bilateral basis, with inspections to be undertaken by personnel of the supplying party.

The safeguard rights specified in Article XII of the IAEA Statute, and mirrored in the bilateral agreements of the principal suppliers, were unprecedented in international agreements. The central feature is, "access at all times to all places and data . . . as necessary to account for . . . materials . . . and to determine whether there is compliance with the undertaking against use in furtherance of any military purpose . . ."

While the provisions relating to inspection are the central feature, the safeguard rights enumerated in Article XII include other important measures which, in combination with inspection set the basic character of international safeguards for the indefinite future.

Of particular significance, Article XII also provides for the maintenance of records and the delivery of reports by States to the Agency "to assist in ensuring accountability." These provisions reflect the realization that safeguards could not, in practical terms, depend on the operation of the accountability system, by the safeguarding authority itself. Rather, the inspectorate was to accomplish this through a process of verifying information developed and reported, in the first instance, by the State. Nevertheless, the Statute leaves no doubt that the basic responsibility for verification rests with the Agency itself.

Other important features of the safeguard rights appear in Article XII.A.5. This paragraph is devoted to the issue of reprocessing and plutonium, which was recognized at the time as of central importance to the verification of peaceful use undertakings. This paragraph goes beyond the concept of verification by according to the Agency specific approval and operational authority. In regard to the former, the Agency is accorded the right "to approve the means to be used for chemical processing," but only in the limited sense of ensuring safeguardability. Despite later contentions to the contrary, the presence of this paragraph leaves no doubt that reprocessing was envisioned from the outset of the peaceful nucear era and that the safeguards system was to deal with it.

The operational feature of this paragraph, which has not yet been implemented, gives the Agency the right "to require deposit of any excess" produced material over what is needed for peaceful research or reactor use. Since any requests to withdraw material in excess of current needs would give rise to an immediate obligation to return the excess material, the provision makes it clear that a key feature of any IAEA plutonium storage arrangement would be the immediacy of need for any material requested to be returned.

The safeguards rights of the Agency statute, developed as they were at an early stage in the evolution of peaceful uses of nuclear energy represent an impressive achievement, which has well served the objective of helping assure compliance with peaceful use undertakings. As in the case of all basic charters, however, the rights established in the Statute left important issues to be decided in the course of implementation, as subsequent developments in the evolution of safeguards have shown.

BILATERIAL AND REGIONAL IMPLEMENTATION

Although sometimes viewed as an unfortunate distraction from the objective of international safeguards, bilateral implementation of safeguards, which extended from the mid-1950's until the early 1960's, before being displaced by Agency safeguards, in fact made important contributions to the early development of safeguards. It was during this period of bilateral implementation that the principal of active application of safeguards rights was firmly established, despite a school of thought that the rights alone would fulfill their purpose if held in reserve and exercised only under unusual circumstances.

It was during this period, too, that the essential distinction between domestic materials accountability as practiced in national nuclear programs for a number of years and international safeguards was clearly appreciated. In national systems of accounting and control, diversion by or at the direction of the state itself is, by definition, of no concern and the system is directed toward proper management of valuable material and the detection of possible theft or diversion at a subnational level. For international safeguards, diversion by the state itself cannot be excluded and, unlikely as such diversion may be, its detection is the ultimate objective of the system.

The appreciation of this distinction led to the enunciation of the principle of independent verification, which is fundamental to the effective application of safeguards. Independent verification means simply that, while information provided by the state system of accounting and control may be employed by the inspectorate, all such information must, in the final analysis, be subject to confirmation on the basis of facts obtained by the inspectorate itself, and not supplied by or derived from the state.

A parallel development of importance to the evolution of international safeguards was the establishment of the multinational safeguard system of the European Atomic Energy Community (Euratom). The provisions of the Euratom Treaty authorizing these safeguards were, like those of bilateral safeguards, in close conformity with the safeguards provisions of the IAEA Statute.

The fact that the Euratom system was applied not by an international organization of broad membership but by a regional organization of closely related states was a political distinction of obvious importance, but one which did not detract from the significant contributions of Euratom safeguards to the development and acceptance of technically effective safeguards.

DEVELOPMENT OF THE IAEA SYSTEM

Despite the deliberate similarity between the safeguards rights of bilateral and regional systems and those of the IAEA, the development of the IAEA system followed a different and slower course. Some of the reasons were of an administrative and logistic nature, reflecting the fact that as a new organization, the IAEA lacked a safeguards staff and had no prior experience comparable to that of national materials accountability groups on which to depend. Political conditions of the era also undoubtedly played a part. There was, however, one important distinction between the Agency safeguards rights and the similar ones enumerated in bilateral agreements, which provided the juridical basis for the differing evolution. This is the provision of the Statute which indicates that the Agency possesses the enumerated rights and responsibilities only "to the extent relevant to the project or arrangement."

In the implementation of bilateral safeguards, at least by the United States, the safeguards rights of the agreements were relied upon directly and no steps were taken to specify to bilateral partners how and to what extent these rights would be applied in practice. Despite this precedent, it became clear that before IAEA safeguards implementation could begin, some guidelines would have to be established as to how the Agency would conduct safeguards.

It was clear even at this early stage that the level of inspection required for large, complex facilities would be substantial - quite probably extending to resident or continuous inspection in the case of large bulk handling facilities. At this point, another critical decision in the development of international safeguards was reached. This was to approach the development of Agency safeguards on a step-wise, evolutionary basis, beginning with the development of guidelines for the relatively small and simple facilities then in service and proceeding to larger and more complex facilities only as required and as experience allowed. Thus, the Agency's first safeguards system was a set of procedures for small reactors - under 100 MWT. The main question, as could be anticipated, was the frequency of inspections, and a formula was adopted providing for maximum inspection frequencies up to 6 per year, depending on reactor size. This first step, limited as it was, allowed the process of transferring implementation of safeguards from bilateral arrangement to the IAEA to begin.

As IAEA safeguards implementaton proceeded, a number of issues arose. Foremost, of course, was the limited coverage of the first system, which did not encompass even the modest size power reactors which began to come into service in the early 1960s. Another major deficiency of the first system was its failure to deal with the question of safeguards over subsequent generations of nuclear material, since this issue is generally not encountered in research reactor operations. Another issue which required resolution in both bilateral and international circumstances was the distinction - previously not made clear - between the circumstances which require safeguards, and the safeguards to be applied once these circumstances arise. At the same time, the concept began to emerge that only nuclear materials are subject to safeguards, although safeguard measures such as inspection necessarily extend to facilities in which such material is located.

In response to these and other needs and questions, the system was extended in 1964 to large reactors, without limitation on size. This extension extrapolated the safeguards frequency formula adopted for smaller reactor, reaching a frequency that permitted "access at all times" for reactors producing 60 kg or more of plutonium annually, thus encompassing virtually all large power reactors. The application of safeguards to all subsequent generations of safeguarded material was also provided for.

During this same time period, an important and precedent making step in the direction of both improving the Agency's safeguard capabilities and furthering the acceptability of Agency safeguards, was taken. This was the U.S. voluntary offer to accept safeguards at several typical U.S. reactors. This experience enabled the Agency to develop and demonstrate its safeguard techniques and train inspection personnel, while demonstrating to Member States that safeguards do not represent an onerous burden.

With the extension to large reactors accomplished, attention was turned to the problem of safeguarding reprocessing facilities. This problem was recognized as being much more difficult, not only technically but in terms of anticipated reservations with respect to the continuous inspection which would clearly be necessary at large reprocessing plants. In 1965, agreement was reached on an extension of the system to reprocessing, incorporating the provision that "for plants having an annual throughput of more than 60 effective kilograms, the right of access at all times would normally be implemented by means of continuous inspection."

In 1968 the system was completed by addition of similar provisions for large fabrication facilities. The result of these separate actions, incorporated in a single document designated Information Circular 66, remains in efect today as the safeguard system applicable to non-NPT parties.

INFCIRC 153

As the negotiation of the NPT proceeded, demands were made by a number of potential Treaty parties that the Agency safeguard system be reviewed in light of the anticipated requirement of the Treaty that all of the country's nuclear installations be placed under safeguards. The resulting review, conducted in 1970-1971 by a Committee of the IAEA Board of Governors, led to a number of important new concepts and adjustments, incorporated into a new safeguards document designated INFCIRC 153.

In one important respect, the INFCIRC 153 system represents an implementation of a principle which had already been adopted in the Nonproliferation Treaty itself. This is "the principle of safeguarding effectively the flow of . . . material by the use of instruments and other techniques at certain strategic points." The strategic points concept represents a rationalization of the tendency, expressed in the IAEA statute itself, to concentrate safeguards efforts on nuclear material in recognition of the fact that the diversion of material from its authorized use is the critical step in a violation of peaceful use undertaking.

The motivation for the "strategic points" concept was the traditional concerns on the part of states with their potential interference with operations and the risk of compromise to commercially valuable information. At the same time, it was recognized that a rigid limitation of inspection access to pre-selected points could reduce safeguards effectiveness. Given these considerations, INFCIRC 153 calls for application of the "strategic point approach" only to the extent that present or future technology permits, and defines strategic points as all the points necessary and sufficient for effective verification. Moreover, special inspections are not limited to strategic points.

The manner in which the strategic points concept was dealt with in INFCIRC 153 reflects an important approach employed in a number of areas in 153, and, to a more limited degree, even in INFCIRC 66, as well. This is to make every effort to minimize safeguards intensity and increase predictability under normal circumstances, while preserving the opportunity to take additional action when circumstances require. In this way, the statutory "access at all times to all places and data "has been preserved, while affording states guidance as to how safeguards will be applied under normal conditions.

INFCIRC 153 contains a number of other new features of importance. These include:

- In keeping with the full-scope safeguards requirements of the NPT, the State's undertaking to accept safeguards on all its peaceful nuclear activities, and the Agency's right and obligation to apply its safeguards to all such activities.

  This key provision gives the Agency not only the broad authority but the obligation to apply safeguards to all nuclear materials which are presented in the state, except for allowed non-explosive military uses. It leaves unanswered, however, the practical question of how the Agency is to fulfill its obligation in respect to undeclared material and facilities, in the absence of a capability to search out such installations.

- Explicit recognition of the principle of independent verification. Specifically, INFCIRC 153, provides that the Agency is to verify the findings of the State's system of accounting and control through independent measurements and observations, thus avoiding any misconception that the Agency's role is simply to assure itself as to the technical effectiveness of the State's system.

- Explicit recognition of containment and surveillance as important complementary safeguards measures.

- The principle that the Board of Governors may take the remedial action provided by the Statute whenever the Agency is unable to verify that there has been no diversion, and need not reach a definitive conclusion of non-compliance.

- In one important respect, INFCIRC 153 places a constraint on the Agency which is absent from INFCIRC 66. Under INFCIRC 66, the basic control of intensity of inspections is exercized through limitations on inspection frequency, and for most major nuclear power installations the frequency allowed is "access at all times." Thus, there is no ceiling on routine inspection effort under INFCIRC 66 except that imposed by resource limitations.

  In INFCIRC 153, inspection effort limitations, rather than frequency limitations, were adopted. The negotiation of these limits was one of the most complex and difficult issues in the development of 153. As in the case of the inspection frequencies of INFCIRC 66, however, the limitations of INFCIRC 153 apply only to maximum routine inspection effort and do not restrict the Agency's ability to undertake additional inspection should circumstances indicate these are required. Both ad hoc inpsection (those conducted prior to conclusion of subsidiary arrangements) and special inspections - (those conducted when routine inspections are "not adequate for the Agency to fulfill its responsibilities under the Agreement") - can be undertaken without limitation on either access or inspection effort.

Although INFCIRC 153 contains, these and many other features not present in the older system, the basic thrust of the system; specifically, the central role of inspections to achieve independent verification, with the assistance of records and reports provided by the States, remains unchanged.

A further distinction between INFCIRC 66 and 153 is the absence in the earlier document of any reference to subsidiary arrangements. Nevertheless, the Agency has followed the practice of developing more detailed arrangements under both INFCIRC 66 and 153 Agreements. These arrangements are unpublished since they may contain confidential information on the design or operation of a State's facilities, and are not reviewed or approved by the Agency's Board of Governors. Accordingly, it would be inappropriate if such arrangements were to restrict in any way the Agency's rights as provided in published safeguards Agreements approved by the Board of Governors.

Both INFCIRC 66 and 153 have in common important assurances that safeguards will be conducted in a manner designed to avoid interference with peaceful nuclear activities, and to protect proprietary confidential information "obtained by" the Agency in the course of safeguards implementation.

Another important safeguards development arising from conclusion of the NPT has been the voluntary offers of several nuclear weapons states to subject their own peaceful nuclear activities to IAEA safeguards. The safeguards applied in response to these offers do not, of course, limit the nuclear defense activities of the nuclear weapons states, and were not intended to do so. Nevertheless, while experience to date has demonstrated the burden of safeguards to be extremely small, the offers serve the important objective of avoiding inequities that might result if safeguards were applied to the peaceful program of only non-nuclear weapons states.

Since the adoption of INFCIRC 153, Agency safeguards implementaton has grown quickly, with some 500 major installations in some 50 countries now under safeguards. This represents a fourfold increase since 1970. During the same period, the Agency safeguards professional staff has grown from some 50 individuals to some 200. Safeguard expenditures are currently about $20 million annually, corresponding to somewhat more than one quarter of the IAEA budget. Despite the growth in the Agency safeguard resources, safeguards, and especially inspection manpower has not kept up with requirements, and the inspection effort actually undertaken has fallen short of the desired level by a sizeable margin.

From the outset of safeguards implementation, Agency safeguards have been financed predominantly from the Agency's assessed budget. This approach reflects the conclusion that safeguards are of benefit to the Agency's membership as a while, and their costs should therefore be widely shared. Following the development of INFCIRC 153, however, a special formula for safeguards financing was adopted which minimizes the impact of safeguards costs on the Agency's developing Member States, in recognition that most of these states will not in the near future be the direct beneficiaries of nuclear power. As a result, safeguard costs are now overwhelmingly borne by the industrialized countries which are the dominant users of nuclear facilities and materials.

Despite these special financing arrangements, overall safeguard costs and the balance between these costs and the resources available for technical assistance has remained a matter of some controversy. Technical assistance resources, however, have also been growing substantially, and in 1980 totalled approximately $19.5 million, essentially the same level as safeguard costs. While the balance between these two essential IAEA activities merits careful and continuing review, comparison of the growth of the technical assistance program in the Agency with that in other international organization leaves little doubt that the Agency safeguards activities have led to a considerably higher level of Agency technical assistance than would otherwise be the case.

Although safeguards costs are substantial in absolute terms, they represent an extremely small element in the cost of nuclear power. The Agency estimates these costs at about 3/1000's of a cent per kilowatt hour of electricity generated, corresponding to only a small fraction of a percent of total generating costs. Illustrating the same point, under INFCIRC 153, the maximum routine inspection effort for reactors is 1/6 of a man year per reactor, and actual routine inspection effort has been well below this level. In contrast, the guard forces employed at such units to provide protection against domestic threats are routinely of the order of 35 persons or more.

A conclusion which can be drawn from these facts is that the level of safeguard costs remains well below levels which would create any significant burden on either nuclear power generation costs or international resources.

SAFEGUARDS RESULTS AND PERFORMANCE

The adoption of two Agency safeguard systems, and the conclusion of safeguards agreements between the Agency and the relevant states has provided an appropriate framework for the conduct of international safeguards. It is now useful to examine how the implementation of these safeguards has evolved, and what problems have been encountered.

From the outset, it was recognized that safeguards, if they are to be successful, must meet two criteria, they must be acceptable to the states in which they are to be applied, and they must be effective in achieving their objectives of verification, deterrence, and, in the unlikely event of violations, detection.

The evidence to date is that the criterion of acceptability has been met. While a few states with nuclear activities have not accepted safeguards on all of their activities, the reasons for this appear to be political in nature, and not because of concern as to the possible intrusiveness, costs, or risks to proprietary information which might accompany safeguards on peaceful nuclear activities. At the same time, a number of states which conditioned their ratification of the NPT on an assurance that safeguards would not be unduly burdensome have concluded that this condition was fulfilled and proceeded with acceptance of the Treaty and the accompanying safeguards. No reports of dissatisfaction by states in which safeguards are applied with the safegurds system or its implementation by the Agency have emerged. Thus, while some disagreement and friction are inevitable in the application of these novel arrangements, safeguards have apparently fulfilled early expectations that they can be executed without significant inconvenience and within acceptable limits of cost.

The assessment of the effectiveness of safeguards is a more complex matter, in part because of the inherent difficulty of establishing that the failure to detect diversion provides adequate assurance that none has occurred. To assist both in designing effective systems and assessing their effectiveness, safeguard objectives, even if only qualitative in nature, must be formulated. INFCIRC 153 states that the objective of safeguards is "the timely detection of of diversion of significant quantities of nuclear material" from peaceful uses to nuclear explosives "or for purposes unknown," and the deterrence of such diversion by the risk of early detection.

An important aspect of this objective, which is sometimes overlooked, is that diversion is expressed not in terms of a physical removal of safeguarded material from one location to another, but in terms of the application or use made of safeguarded material. It is evident that a diversion can occur, within the clear meaning of this provision, if safeguarded material is put to improper use, even if no change in location or even in physical form takes place.

The qualitative objective of INFCIRC 153 has been supplemented by the informal adoption of Agency safeguard goals, which express four main safeguards performance yardsticks - detection sensitivity, detection probability, timeliness, and "false alarm" probability - in quantitative terms. Use of these goals has been criticized on the grounds that they may unnecessarily discredit safeguards if, as is likely, they cannot be met in all circumstances. The counterargument is that even goals which are difficult and perhaps impossible to achieve may be useful in guiding improvement efforts and allocating safeguard resources.

Whatever the merits of the suggested goals, the fact is that goals as rigorous as those in use are not yet achievable in some practical situations, and may not be realistically achievable in the foreseeable future. The difficulty arises in particular in large bulk-handling facilities, such as reprocessing plants, where the inherent imprecision in nuclear material measurements, coupled with high throughputs can over relatively short periods of time lead to uncertainties in accountability well in excess of the desired detection sensitivity. That this would be so is hardly surprising, and has been recognized since the earliest days of nuclear material accounting.

This problem, among others, has given added impetus to the development of containment and surveillance measures to supplement materials accountability. Indeed, the technical problems of safeguards - which have proven more difficult than earlier anticipated - have stimulated a major development effort, at a scale that would have been unforeseeable only a few years ago, spanning the whole range of safeguards technology. Because of limitations on IAEA resources, much of this effort is being funded by national means.

Beginning in 1978, a special Advisory Group of the IAEA on Reprocessing Plant Safeguards has been examining the problems of safeguarding this class of facilities. This group recently reached its conclusions, which generally endorsed the desirability of employing a combination of measures including, improved conventional materials accountancy near-real-time accountancy, and containment and surveillance. Of particular importance is the Group's recommendation that safeguards must be taken into account in the design of such a facility from an early stage, if an effective safeguards approach is to be achieved.

While technical issues are a major element in recent safeguards history, they are by no means the only problem area, nor are the technical issues confined to bulk-handling facilities. In 1981, the IAEA concluded for the first time that it was no longer able adequately to verify compliance at certain on-load-refuelled reactors where independent verification of fresh fuel was not possible. On the basis of Agency statements, it appears that these safeguard problems can be overcome through the application of additional technical measures, if and when agreement on their implementation is reached. It also appears that the deficiencies could be overcome by increased use of inspection manpower, on which no limitations are placed by the applicable safeguards system, INFCIRC 66. Thus, the issue, while arising from technical difficulties, also involves questions of negotiation, the allocation of safeguard resources, and the role of subsidiary arrangements in defining how the Agency should apply the safeguards envisioned by its system and agreements.

Another issue which has come to public attention is the obligation of the Agency in respect to safeguarding "undeclared" nuclear facilities or materials in NPT states which have agreed to accept safeguards on all their peaceful nuclear activities. It is, of course, both impractical and inappropriate for the Agency to search out activities or facilities which have not come under safeguards through the initiative of the State, or the direct application of safeguards by the Agency. But recognition of this programmatic limitation is different from its elevation to a basic principle of safeguards implementation. How to rationalize the practical limitation with the more fundamental obligation of ensuring that safeguards are applied to all nuclear material in a state is, thus, one of the challenges facing safeguards today.

The issue of undeclared facilities and materials may be indicative of a broader tendency to approach the implementation of safeguards in an excessively legalistic way. Given a State's vested in the avoidance of suspicion, approaching safeguards in a legalistic and restrictive way cannot be in its interest. A genuinely cooperative approach to safeguards implementation may, thus, be the single most cost-effective way of improving safeguards.

A collateral issue, not specifically involving how safeguards are implemented, is how information with respect to this implementation and its results is made known. The Agency Statute, INFCIRC 66 and INFCIRC 153 all require the Agency to protect information obtained by the Agency in the course of applying safeguards, but this restriction has no application to information on the Agency's own safeguard activities. This important distinction is apparently becoming more generally understood, and the Board of Governors has announced its intention to examine the question of dissemination of safeguards information in 1983. The issue is a complex one, calling for a careful balancing of considerations, since the disclosure of excessive detail on safeguards implementation, could lead to increased reluctance on the part of States to cooperate with the Agency.

CONCLUSION AND OVERVIEW

The question of safeguards effectiveness is a troublesome one, with a large potential for public misunderstanding. No responsible safeguards authority has ever claimed infallibility for safeguards in achieving its objective of verifying compliance or, in the exceptional case, detecting diversion, and human experience tells us that perfection in such efforts is unattainable. Yet, if safeguards are not fool-proof, what purpose do they serve and how far are nations and their authorities entitled to go in basing important judgements and decisions on safeguards results?

Even though imperfect, safeguards can, when effectively implemented, subject would-be violators of nonproliferation undertakings to a high risk of detection, thus providing both an important deterrent to proliferation and verifying with a high degree of probability that nuclear activities declared to be peaceful are indeed so. Where this conclusion can no longer be reached, safegurds can sound the alarm, initiating appropriate responses. There is convincing evidence that safeguards are currently fulfilling these functions in a creditable manner. Given adequate resources, they can continue to do so with an enhanced level of assurance, particularly if full cooperation becomes the norm, so that the withholding of cooperation becomes in itself an important element in the verification process.

These accomplishments are clearly of major importance to the achievement of the goal of allowing nuclear energy to make its full contribution to economic and social progress, without contributing to the risk of further proliferation. Thus, safeguards continue to merit the support and confidence, which they have enjoyed to far as an important element in the nonproliferation regime.

EDWARD J. MARKEY WITH DOUGLAS C. WALLER

NUCLEAR PERIL. THE POLITICS OF PROLIFERATION

(Excerpt)

The IAEA

Many of the world's nuclear facilities, other than those in the nuclear-weapons states, are under IAEA safeguards. The safeguards are set up to ensure that the member nations comply with the 1970 Nonproliferation Treaty—that is, that their nuclear programs are

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peaceful and that no nuclear materials are being diverted for nuclear explosives or other military purposes. The individual countries voluntarily conclude safeguard agreements with the IAEA.

Save for curtailment of IAEA assistance or suspension of membership privileges, the agency has few sanctions it can levy on a state if it uncovers diversion. About the most it can do is sound the alarm that it has detected diversion and let the international community take action. Also, the IAEA concerns itself only with possible diversion *by* the state, not diversion *from* the state. The member nations are responsible for making sure that terrorists or criminals do not get their hands on nuclear materials. The agency keeps an eye on the nations.

The IAEA attempts to set up its safeguards agreements with member nations so that the agency can detect in a timely manner diversion of "significant quantities" of nuclear material.[3] To do this, the agency's Safeguards Department can take various surveillance and containment measures, such as installing tamper-resistant automatic cameras at nuclear facilities or placing seals on fuel containers between inspections.

A good deal of the agency's safeguards work is done through inspections, which consist of an accounting and verification system based on reports submitted by the nation's nuclear facilities. The nuclear plant operator, for example, keeps records on nuclear materials at the facility. The IAEA then reviews these records to make sure all the material is accounted for. The agency supplements its review with visits to the facility, during which IAEA inspectors will actually count or measure nuclear material and compare it to what has been reported by the plant operator. So far, the IAEA reports that it knows of no safeguarded items that have been diverted.

The Safeguards Myth

While on paper the IAEA safeguards may appear adequate, in reality they are not. The international inspections system, it turns out, has glaring weaknesses, which undermine the very belief that the peaceful atom can be both promoted and kept peaceful.

As noted before, while 115 nations subscribe to full-scope IAEA safeguards, 48 nations do not because they have not signed the 1970 Nonproliferation Treaty. The nonsignatories include nations believed to be clandestinely building bombs, such as India, Pakistan, South Africa, and Israel.

In addition, the countries that have signed the treaty are allowed to back out of it at any time. This makes signing and accepting safeguards in many ways an attractive option for countries intent on building a bomb. Iraq, for example, is able to collect all the nuclear materials and technology needed to build the bomb, all done under IAEA safeguards. Once Iraq is ready to fabricate a weapon, it only has to give three months notice and it can withdraw from the treaty and the IAEA inspectors are off its soil.

Also, while the treaty prohibits a nonweapons state from acquiring or manufacturing "nuclear weapons," it is vague about whether a country can take all the necessary steps short of building a bomb, such as designing or testing its non-nuclear components.

There are also numerous problems with the safeguards themselves:

Conflict of Interest

The IAEA has two responsibilities: (1) to promote and (2) to safeguard nuclear power. The agency, however, has been more concerned with the former than the latter. The question arises: Can an agency both promote an enterprise and regulate it? Many believe it cannot. "There is an inherent conflict of interest between promoting and regulating civilian nuclear power activities, noted Democratic Senator Gary Hart of Colorado. "In this country, it led to the establishment of the independent Nuclear Regulatory Commission to replace the Atomic Energy Commission."[4]

Inspections and Accounting Weaknesses

The IAEA's some 140 inspectors have been criticized as being poorly trained and spread too thin for the 700 nuclear reactors and related facilities around the world under safeguards.

The agency's accounting methods, which are being used to keep track of nuclear fuel, have also been criticized for being too loose and too dependent on host-country figures. The problem is due partly to the nature of the material being accounted for. During chemical reprocessing, for example, measurement limitations and weight variations can cause up to 1 percent out of every 220 pounds of material to be unavoidably unaccounted for.

The IAEA detection standards, however, are also established out of political compromise so as to be as unobtrusive as possible for the host country. For example, the annual detection threshold the agency has set (this is the amount of material the IAEA will allow to be classified as unavoidably unaccounted for in a country before it suspects diversion) is about eighteen pounds of plutonium – enough to fuel one explosive device. The IAEA standards, in effect, have a margin of error of about one bomb per year.

The Secrecy

Worse still, no one outside of the agency knows whether these detection standards and safeguards actually work. To insure that industrial secrets will not be leaked to other nations, IAEA inspection agreements with host countries and the results of those inspections are kept confidential. "In our opinion," concluded a 1976 General Accounting Office report, "the United States does not possess sufficient information to judge the adequacy of the current IAEA system."[5]

The U.S. NRC further warned in November 1981 that it was "concerned that the IAEA safeguards system would not detect a diversion in at least some types of facilities. In addition," it said, "we are not confident that the member states would be notified of a diversion in a timely fashion."[6]

Deception and Loopholes

The IAEA's inspection and auditing procedures vary so much from country to country and are so riddled with loopholes, that the host nation would have little difficulty deceiving an inspector. A 1976 report by Barber Associates, prepared for the U.S. Energy Research and Development Administration, shows how the deception might come about:

> In the case of a suspected diversion by a national government the response to such an accusation would be extremely difficult. It is unlikely that an international inspector will ever witness a diversion; all he will have to go on will be indirect evidence – discrepancies between the suspect nation's domestic accounting system and the audit of the international inspectorate, breakdown in remote observation equipment, or suspicious procedural roadblocks in the way of international inspection. The nation involved could argue that such discrepancies were due to human error, mechanical failure, or normal process loss – and it could well be correct. In such an uncertain atmosphere, the IAEA would be very hesitant in making public accusations.[7]

One of the best real-life examples of the deception and loopholes comes from Iraq. On June 19, 1981, about two weeks after the Israeli bombing of Osirak, Roger Richter, an American inspector with the IAEA who was assigned to the Middle East section that dealt with Iraq, testified before the Senate Foreign Relations Committee.

Richter, who resigned from the IAEA about a week after the Israeli bombing, was the only American assigned to Iraq. Since 1976, the other inspectors have come from the Soviet Union or Hungary, two of Iraq's allies.

"Countries have a right to veto inspectors from whatever countries they choose, a right they regularly exercise," Richter pointed out to the committee. "As an accepted inspector, you must keep in mind that any adverse conclusions you might reach as a result of your inspections would have to take into account your country's sensitivity to how this information might affect relations with Iraq."

Iraq was always given several weeks notice of a planned inspection, more than enough time to hide any secret activity. Also, under the agreement the IAEA had with Iraq, the agency was "limited to only three inspections per year," Richter testified, "usually spaced at approximately four-month intervals. Since the entire reactor can be emptied of the clandestine uranium target specimens within days, you as an inspector face the fact that by the time you arrive to verify the declared inventory of fuel elements, which power the reactor, all evidence of illicit irradiations could be covered up."

Furthermore, loopholes in the IAEA inspection agreement enabled a number of critical items at Osirak to be exempted from agency safeguards—such as the pilot reprocessing facility, fuel fabrication equipment, and *100 tons* of uranium oxide.

The IAEA inspector spends most of his inspection time looking over accounting papers put in front of him by the plant operators. "The difficult part of the job is that you must prepare yourself mentally to ignore the many signs that may indicate the presence of clandestine activities going on in the facilities adjacent to the reactor," Richter said. "You will now complete a standard report, filling in the blanks. You will try to forget that you have just been party to a very misleading process."[8]

The Goodwill Factor

In the end, IAEA inspectors depend on the goodwill of the host country. But even that sometimes is missing. For example, on September 30, 1980, eight months before the Israeli bombing, two

Phantom jets that bore the markings of the Iranian Air Force (some suspected they were Israeli jets in disguise) attacked Osirak, slightly damaging the facility. IAEA inspectors were temporarily barred for about two months from entering Iraq to check the secret whereabouts of twenty-six pounds of highly enriched uranium the French had supplied.

The Paper Tiger

Even if diversion is detected, the international community in the past has been loathe to do anything about it. India is the best example. The United States only disapproved of India's 1974 explosion; it did not stop shipping uranium. And, in the face of further refusals to accept international safeguards or to renounce nuclear explosions, the Executive Branch went out of its way to again feed an Indian reactor.

The manifold weaknesses of the IAEA point to only one conclusion: The international safeguards system that the world has established to prevent the spread of nuclear weapons sits atop a house of cards.

The 1970 Nonproliferation Treaty, which 115 nations have signed, depends on an inspections and control system that will not stop the spread of nuclear weapons. Furthermore, the 1978 U.S. Nonproliferation Act rests upon the same inadequate control system. The 1978 act requires that countries that have not signed the 1970 international treaty adopt full-scope IAEA safeguards before the United States will supply them nuclear materials. The countries must place all their nuclear facilities under the IAEA inspections and control system, as if they were signatories of the 1970 treaty. But even full-scope safeguards are inadequate. Even if India had agreed to safeguards and the United States had shipped all the fuel, the problem of proliferation would have remained. As Iraq has demonstrated, the presence of IAEA inspectors in a country does not prevent it from building a bomb.

The Reagan Administration, however, would have the world believe otherwise. That is because Ronald Reagan has big plans for worldwide nuclear power. And those plans include maintaining the charade that the IAEA will remain a policeman of nuclear power.

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THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA): IMPROVING SAFEGUARDS

HEARINGS

BEFORE THE

SUBCOMMITTEES ON
INTERNATIONAL SECURITY AND SCIENTIFIC AFFAIRS

AND ON

INTERNATIONAL ECONOMIC POLICY AND TRADE

OF THE

COMMITTEE ON FOREIGN AFFAIRS
HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

SECOND SESSION

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STATEMENT OF PETER A. BRADFORD, COMMISSIONER, U.S. NUCLEAR REGULATORY COMMISSION

Mr. **Bradford**. Yes, sir. Thank you, Mr. Chairman.

I have four loosely linked points that I want to make. The first is that the IAEA presently exhibits many of the characteristics that have been clear precursors to trouble in other regulatory schemes with which more than 10 years at the head of regulatory agencies have made me familiar.

Second, the issue of the adequacy of the safeguards that are applied to U.S. exports does not seem to me to be separable from the first of the criteria administered by the NRC pursuant to the Nuclear Non-Proliferation Act.

Third, the Congress ability to appraise the second point is currently being severely undercut by the quality and untimeliness of the information provided to you from the executive branch.

Fourth, the ability of IAEA safeguards to function as an effective deterrent is open to question. The IAEA is reported to have admitted to an inability to safeguard certain types of reactors in some countries.

Beyond that, its inability adequately to safeguard plutonium in reprocessing plants and some fabricating facilities under programs that would disperse substantial quantities of plutonium throughout the world is not subject to serious dispute.

Regarding the first and fourth of these points, I do not intend to be unduly critical of the IAEA itself. It has a difficult and unique mission among international organizations, and its functions in many ways deserve encouragement and strengthening.

Furthermore, it is under new leadership with a consequent potential for improvement. Unfortunately, its mission does not allow for the imprecision that we may tolerate in international agencies, and to point overloudly to its institutional achievements while ignoring the gap between what it can do and what it must do is to fall into exactly the same "no chain is weaker than its strongest link" type of thinking that helped to blind the Nuclear Regulatory Commission to the problems that led to Three Mile Island.

A brief listing of the factors that the IAEA shows in common with other troublesome regulatory situations would include the following:

Its charter mixes promotion and regulation and a majority of its governing board are at least as interested in the promotional aspects.

Secrecy of various sorts precludes informed discussion of aspects of the IAEA that need to be strengthened, especially if it is to have the slightest chance of coping with the consequences of administration policies on reprocessing and breeder reactors.

Three, the semantics that have preceded trouble in this country have begun to crop up in the context of discussions of the IAEA. Thus, statements such as "no evidence of diversion" or "the IAEA is not perfect," in the former case do not acknowledge the limitations in the data base and in the latter case set up a useless and irrelevant standard.

In this context also, statements about the limitations of international organization and the IAEA's unusual and promising nature are, while true, beside the point.

No matter how unusual and promising a young child were to be, one would not give that child custody over matches to prove one's faith. To question the gap between the IAEA's capabilities and its present and future mission is not to call into question the good faith of its top officials or its unique achievement as an international institution.

There are general indications of concerns from IAEA employees taken lightly by management and of failures of important information to flow quickly to those who need it.

With regard to my second overall point, the extent to which the NRC need consider the reality of the safeguards being applied in making its criterion 1 determination, I will be brief.

The Commission and individual Commissioners have corresponded at length with the Congress on this question. My own view is that the paper application of IAEA safeguards provides a reasonably strong presumption that, but no more than that, criterion 1 is met.

However, if the Commission has information to the effect that the safeguards are inadequate, I do not see how it can blindly make the finding "that IAEA safeguards are applied."

The fact that IAEA inspectors may go to a particular country, or that IAEA paperwork may be in order in a particular country, does not mean that IAEA safeguards are applied if, for example, the equipment is not working or the inspectors are for some reason unable to do their jobs.

What is being applied in that case is some fraction of the IAEA safeguards program.

It is hard to imagine that the Congress intended for us to find "that IAEA safeguards will be applied" in situations in which the IAEA itself would not defend the safeguards practices at issue.

My third point is that you have not been getting the information that you need and that you have asked for over the last six or seven months. When I compare material that I have seen with what some of your committee staffs tell me what they have been told, the extent of the gap is dramatic.

It is this history that caused me to seek to reply at somewhat greater length than my colleagues to the questions asked in November by Congressmen Ottinger and Dingell and Senator Hart.

As you know, those responses, which were classified and would not have given away intelligence sources and methods, have been censored by the executive branch and you do not have them to this day.

The issue here is not the revelation of classified information, for my letter itself would have been classified. The issue is not whether the NRC should be the agency to provide the information, all other things being equal, for all other things are not equal.

You have been seeking this information for a long time from the executive branch. You have not been getting it, and you will have great difficulty reviewing criterion 1 of the NNPA, among other things, without it.

My fourth point, the inability of the IAEA to safeguard certain materials and certain reactor types to a level capable of providing reasonable assurance of a diversion and timely warning is not intended to be different from the point that the Commission made in its November letter.

It is worth reiterating here only because I understand that the executive branch is now labeling it "not to be technically well founded."

If this statement is intended as a matter of opinion, it is ignorant. If it is intended as a statement of fact, it is false. Information available to all of the agencies involved make this clear beyond the possibility of informed argument.

The road to Three Mile Island was paved with similar self-delusions, and I remind you that this one is coming from the same agencies that sought for many months to conceal from the Congress that U.S. heavy water had been involved in the preparations for the 1974 Indian nuclear explosion.

I am sorry to have to leave my relationship with this committee and with my friends in the executive branch agencies in question on so disputative a note. However, the stakes in the area of nuclear proliferation are uniquely high, and the barriers and deterrences are not what they could be.

The self-reinforcing processes of secrecy and self-delusion that have long troubled nuclear energy and governmental regulation in general are undermining the prospects for improvement here.

If they are permitted to continue as they have at the same time the world moves toward a fuel cycle that makes increasing use of plutonium, the hopes that Congress, and this committee in particular, had in passing the Nuclear Non-Proliferation Act in March 1978 will be betrayed with possible consequences that can truly be termed catastrophic.

Chairman ZABLOCKI. Thank you, Mr. Bradford.

STATEMENT OF HON. GARY HART, A U.S. SENATOR FROM THE STATE OF COLORADO

Senator HART. Mr. Chairman, I want to thank you for your customary hospitality. I don't want to impose myself before your opening statement, and I am perfectly able and willing to wait to hear what you have to say.

Mr. BINGHAM. That is all right. Go ahead.

Senator HART. Well, I thank you once again, both to you and Chairman Zablocki, for your your invitation to appear before these two very important subcommittees today.

ADEQUACY OF SAFEGUARDS OF KEY IMPORTANCE

Mr. Chairman, the issue before us—the adequacy of international safeguards to detect the diversion or theft of nuclear materials that might be used in nuclear weapons—is one of our society's and our world's most serious problems.

Until concerns about the adequacy of safeguards are resolved, in my judgment the United States should suspend all nuclear exports to non-nuclear-weapons countries. There can be no justificaiton for such trade without verifiable and enforceable assurances that our customer nations will not build nuclear weapons with those exports.

Effective international safeguards are of course the key to preventing the further spread of nuclear weapons. The safeguards system is to nonproliferation what verification is to arms control. If ineffective, all of our efforts will go for naught.

Important as it is, the international safeguards system attracted little attention until very recently, and that is I think unfortunate. Now skepticism is growing about the effectiveness of safeguards to prevent the misuse of nuclear materials and facilities.

The criticism of safeguards escalated rapidly when, as you know, Israel bombed the Iraqi research reactor, a resounding vote of no confidence by Israel in the international safeguards system.

INSPECTION AT IRAQI NUCLEAR FACILITY

That criticism continued with the very disturbing testimony before a Senate committee by an International Atomic Energy Agency inspector who described a safeguards inspection of that same Iraqi reactor shortly before it was destroyed. He described how inspectors had to use flashlights to inspect the facility. He described how inspectors could not enter the room where some of the reactor fuel was stored because they didn't have a key.

According to this same inspector, and I quote:

> The difficult part of the job is that you must prepare yourself mentally to ignore the many signs that may indicate the presence of clandestine activities going on in the facility adjacent to the reactor, facilities that you were not permitted to inspect.

Of course, last November the Nuclear Regulatory Commission expressed concern to several Members of Congress and I quote, "That the IAEA safeguards system would not detect a diversion of nuclear materials in at least some types of facilities." Further the Commission said it was "not confident that the member states (of the IAEA) would be notified of a diversion in a timely fashion."

NRC CONCERNS

The NRC's concerns are easy to understand, given the weaknesses in the safeguards system. In effect the NRC stated what many of us have suspected. Their hopes of holding the further spread of nuclear weapons rests on safeguards that neither make the world community safe nor guard against nuclear proliferation. They are little more than a facade that legitimizes continued and expanding nuclear trade, despite the growing danger that nuclear material will be stolen or diverted, without detection, to build nuclear weapons.

Despite the inadequacies of safeguards, the Reagan administration wants to make the United States, to use its term, a "reliable supplier" of nuclear technology and materials throughout the world. Yet, to protect the future of civilization, we don't need reliable suppliers, but a safeguards system that will guarantee reliable customers.

The United States must respond to the legitimate and I think growing concern about the effectiveness of these international safeguards.

I would like very briefly, Mr. Chairman, to make a few proposals.

STEPS THE UNITED STATES SHOULD TAKE

First, as I mentioned earlier, I think the United States should suspend immediately all nuclear exports to nonnuclear weapons countries at least until the NRC can find that safeguards are adequate to detect the diversion or theft of nuclear material. Commonsense dictates that we should not engage in nuclear commerce without independent assurance that our customer nations will not build nuclear weapons with those exports.

Second, I think we should urge the President to convene representatives from all the nuclear exporting nations to seek their agreement to suspend their exports until safeguards have been upgraded.

Third, I think the Congress should pass legislation explicitly requiring the NRC to consider the adequacy of safeguards in its export licensing determination.

As you know, there is an ongoing debate over whether the NRC already has that responsibility. Some persons, myself included, contend that the NRC's general statutory mandate to promote the common defense and security and protect health and safety requires it to consider the adequacy of safeguards in reviewing export licensing applications. Unfortunately, others disagree. Rather than allowing that debate to continue, the Congress should amend the Atomic Energy Act to make the NRC's resposibilities crystal clear.

Fourth, the United States should propose and seek international support for a new autonomous international agency with exclusive responsibility for safeguarding nuclear facilities around the world. Currently the IAEA has dual responsibility for promoting the peaceful uses of nuclear energy and for insuring the effectiveness of safeguards against the misuse of nuclear power programs.

But there is an inherent conflict of interest between promoting and regulating civilian nuclear power activities. In this country it led us to the establishment of the independent Nuclear Regulatory Commission to replace the Atomic Energy Committee. The same reasoning justifies establishing an international nuclear safeguards agency independent of the IAEA.

An international tax established by treaty and imposed on nuclear generated electricity could finance this new safeguards agency.

Finally, Mr. Chairman, the Federal Government should disclose to the public information about the adequacy of safeguards. The Government has invoked national security interests to justify withholding such information, often to protect itself from the embarrassment of its permitting nuclear exports under inadequate safeguards.

The current extensive classification of information about the adequacy of safeguards actually jeopardizes the national security by lulling the public into a dangerous complacency about the adequacy of those safeguards to detect diversion or theft of nuclear material. I think a better informed public would probably insist on stricter restraints on nuclear exports or on upgraded international safeguards.

Mr. Chairman, in 1979 the accident at Three Mile Island warned us of serious deficiencies in our program for regulating civilian nuclear power. A proliferation equivalent of Three Mile Island would pose serious dangers to world peace and the future of civilization.

I am pleased that Congress has begun to examine the effectiveness of international safeguards. I only hope that we are not already too late.

I thank you again, Mr. Chairman, for your invitation and your hospitality in permitting me to appear here.

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PREPARED STATEMENT OF HON. RICHARD T. KENNEDY, U.S. REPRESENTATIVE TO THE INTERNATIONAL ATOMIC ENERGY AGENCY

THANK YOU, MR. CHAIRMAN, I APPRECIATE THE OPPORTUNITY TO BE HERE THIS MORNING TO DISCUSS THE INTERNATIONAL ATOMIC ENERGY AGENCY, AND ESPECIALLY ITS SAFEGUARDS SYSTEM. THE IAEA IS AMONG THE MOST IMPORTANT INTERNATIONAL ORGANIZATIONS, ONE WHICH THE U.S. WAS INSTRUMENTAL IN ESTABLISHING AND ONE WHICH WE HAVE SUPPORTED STRONGLY OVER THE YEARS. ITS SAFEGUARDS ROLE IS A FUNDAMENTAL PART OF THE INTERNATIONAL NONPROLIFERATION REGIME.

IN YOUR LETTER INVITING ME TO TESTIFY YOU REQUESTED THAT I DISCUSS THE FOLLOWING ISSUES:

(1) THE EXTENT TO WHICH THE IAEA IS CURRENTLY ABLE TO FULFILL ITS SAFEGUARDS RESPONSIBILITIES IN AN EFFECTIVE FASHION;

(2) SPECIFIC BUDGETARY PROBLEMS WITHIN THE AGENCY WHICH IMPACT ON THE EFFECTIVENESS OF SAFEGUARDS;

(3) TECHNICAL PROBLEMS WHICH IMPEDE EFFORTS TO DEVELOP EFFECTIVE SAFEGUARDS TECHNIQUES, FOUNDED ON THE "TIMELY WARNING" STANDARD, FOR BULK-HANDLING FACILITIES SUCH AS ENRICHMENT AND REPROCESSING PLANTS;

(4) THE EFFECT THAT CURRENT POLITICAL TENSIONS WITHIN THE AGENCY ARE HAVING, OR MAY BE EXPECTED TO HAVE, ON THE VIABILITY OF THE INSTITUTION, AND ON THE SAFEGUARDS SYSTEM GENERALLY, ESPECIALLY WITH REFERENCE TO THE 1981 GENERAL CONFERENCE;

(5) THE UTILITY AND SCOPE OF THE U.S. ASSESSED AND VOLUNTARY CONTRIBUTIONS TO THE IAEA, WITH SPECIAL REFERENCE TO THE PROGRAM OF TECHNICAL ASSISTANCE TO SAFEGUARDS (POTAS); ALSO, A REVIEW OF OTHER DOMESTIC WORK ON SAFEGUARDS, OUTSIDE OF POTAS, WOULD BE APPRECIATED, WITH SOME INDICATIONS OF ITS POSSIBLE CONTRIBUTION TO THE IAEA SYSTEM; AND

(6) THE PROPER ROLE AND SIGNIFICANCE OF IAEA SAFEGUARDS IN OVERALL U.S. NON-PROLIFERATION POLICY.

REGARDING THE FIRST, THE IAEA'S PURPOSE IS TO FACILITATE PEACEFUL USES OF ATOMIC ENERGY AND TO ENSURE, SO FAR AS IT IS ABLE, THAT ASSISTANCE PROVIDED BY IT OR AT ITS REQUEST OR UNDER ITS SUPERVISION OR CONTROL IS NOT USED TO FURTHER ANY MILITARY PURPOSE.

THE TREATY ON THE NONPROLIFERATION OF NUCLEAR WEAPONS REQUIRES EACH NON-NUCLEAR WEAPON STATE PARTY TO THE TREATY TO ACCEPT IAEA SAFEGUARDS ON ALL OF ITS PEACEFUL NUCLEAR ACTIVITIES. SIMILARY THE TREATY FOR THE PROHIBITION OF NUCLEAR WEAPONS IN LATIN AMERICA, KNOWN AS THE TREATY OF TLATELOLCO, REQUIRES EACH STATE PARTY TO ARRANGE FOR FULL-SCOPE IAEA SAFEGUARDS.

IT IS IMPORTANT AT THE OUTSET TO UNDERSTAND WHAT IAEA SAFEGUARDS ARE AND WHAT THEY ARE NOT. IAEA SAFEGUARDS ARE A TECHNICAL MEANS OF CONFIRMING TO ALL COUNTRIES THAT EACH COUNTRY UNDER SAFEGUARDS IS FULFILLING ITS POLITICAL

OBLIGATIONS. THIS REQUIRES A SYSTEM OF PROCEDURES INCLUDING RECORDS, REPORTS, AND INSPECTIONS, BY WHICH THE IAEA CAN VERIFY THAT SPECIFIED MATERIAL AND FACILITIES ARE NOT BEING DIVERTED FROM THEIR DECLARED PEACEFUL PURPOSES. IAEA SAFEGUARDS ARE A CRITICAL AND INDISPENSIBLE COMPONENT OF THE WORLDWIDE NON-PROLIFERATION EFFORT. BUT THEY ARE NOT THE TOTALITY OF THAT EFFORT.

IAEA SAFEGUARDS ARE PRINCIPALLY A DETECTION AND WARNING RATHER THAN A PREVENTION OR REACTION MECHANISM. THE IAEA HAS NO CAPABILITY TO PHYSICALLY PREVENT DIVERSION AND HAS LIMITED ENFORCEMENT AUTHORITY. THE IAEA HAS NO AUTHORITY OR CAPABILITY TO SEARCH FOR NUCLEAR ACTIVITIES AWAY FROM DEFINED LOCATIONS. IAEA SAFEGUARDS DO NOT INVOLVE POLITICAL JUDGEMENTS BY THE IAEA AS TO THE DEPENDABILITY OR SINCERITY OF NON-PROLIFERATION COMMITMENTS.

SAFEGUARDS SHOULD NOT BE THOUGHT OF AS A SYSTEM IMPOSED BY OTHERS. IT IS IN THE INTEREST OF ALL STATES TO COOPERATE WITH AND ASSIST THE IAEA IN IMPLEMENTING SAFEGUARDS IN AN OPEN AND CONVINCING MANNER. THE ACCEPTANCE OF IAEA SAFEGUARDS ON ALL ITS NUCLEAR ACTIVITIES PROVIDES A MECHANISM FOR A COUNTRY TO SHOW THE WORLD COMMUNITY, INCLUDING ITS NEIGHBORS, THAT IT INTENDS TO USE NUCLEAR ENERGY ONLY FOR PEACEFUL PURPOSES. INSPECTION OF A COUNTRY'S NUCLEAR FACILITIES BY AN INTERNATIONAL ORGANIZATION ENTAILS AN OPENNESS TO PUBLIC

SCRUTINY OF A COUNTRY'S ACTIVITIES, CAPABILITIES, AND INTENTIONS THAT WOULD OTHERWISE BE ABSENT.

IN ASSESSING THE EFFECTIVENESS OF SAFEGUARDS IT MUST BE RECALLED THAT THE IAEA'S TASK HAS BEEN RAPIDLY CHANGING, BOTH QUANTITATIVELY AND QUALITATIVELY. IAEA SAFEGUARDS WERE INITIALLY APPLIED MAINLY TO RESEARCH REACTORS, THEN TO POWER REACTORS. SINCE THE MID-1970'S IAEA SAFEGUARDS HAVE BEEN APPLIED TO A RAPIDLY INCREASING NUMBER OF STATES AS WELL AS TO A GROWING NUMBER AND VARIETY OF FACILITIES.

THE SAFEGUARDS TASK IN THE CASE OF RESEARCH REACTORS AND LIGHT WATER MODERATED POWER REACTORS WAS RELATIVELY STRAIGHT-FORWARD: THE COUNTING AND IDENTIFICATION OF A MODEST NUMBER OF DISCRETE FUEL ELEMENTS. SOME OF THE OTHER SAFEGUARDED FACILITIES PRESENT A MUCH MORE COMPLEX SAFEGUARDS PROBLEM. ON-LINE REFUELED POWER REACTORS POSE MORE COMPLEX SAFEGUARDS PROBLEMS THAN DO OTHER TYPES, BECAUSE OF CONTINUOUS FUEL MOVEMENTS. LARGE AMOUNTS OF MATERIAL IN VARIOUS FORMS ARE PRESENT IN OR FLOW THROUGH "BULK HANDLING" FACILITIES. IN PARTICULAR, REPROCESSING, AND ENRICHMENT PLANTS POSE SUBSTANTIAL CHALLENGES FOR IAEA SAFEGUARDS. A SUBSTANTIAL PORTION OF THE U.S. SUPPORT EFFORT HAS BEEN DEVOTED JUST TO KEEPING THE IAEA SAFEGUARDS SYSTEM ABREAST OF THESE DEVELOPMENTS.

RECENT PUBLIC DISCUSSIONS OF IAEA SAFEGUARDS HAVE CITED A NUMBER OF LIMITATIONS WITHOUT AN INFORMED CONSIDERATION OF THE DEGREE TO WHICH THESE LIMITATIONS DO OR DO NOT

DIMINISH SAFEGUARD'S EFFECTIVENESS. FOR EXAMPLE, THAT INSPECTED STATES MUST AGREE TO THE DESIGNATION OF INDIVIDUAL INSPECTORS HAS BEEN PRESENTED AS A MAJOR DEFECT. WE DO NOT BELIEVE THAT IS THE CASE. INSPECTED STATES HAVE A LEGITIMATE INTEREST IN BEING ABLE TO AVOID THE DESIGNATION OF INDIVIDUALS OBJECTIONABLE TO THEM, FOR EXAMPLE FOR PHYSICAL SECURITY REASONS. IN FACT, THE UNITED STATES SENATE CONSIDERED THIS PROVISION TO BE AN IMPORTANT PROTECTION FOR THE US UNDER OUR OWN SAFEGUARDS AGREEMENT WITH THE IAEA. BESIDES, SAFEGUARDS AGREEMENTS CONTAIN A PROVISION PROTECTING AGAINST OVERUSE OF THIS RIGHT. IN PRACTICE, DESIGNATION OF INSPECTORS HAS NOT BEEN A WIDESPREAD OR SERIOUS PROBLEM.

ANOTHER EXAMPLE IS THE COMPLAINT THAT THE IAEA DOES NOT HAVE THE RIGHT TO LOOK FOR UNDECLARED FACILITIES IN COUNTRIES WITH FULL SCOPE SAFEGUARDS. YET SUCH CHARGES DO NOT CONSIDER HOW COUNTRIES MIGHT REASONABLY BE EXPECTED TO ACCEPT INTERNATIONAL INSPECTORS HAVING A RIGHT OF ACCESS TO ALL PLACES AT ALL TIMES, WITH NO RESERVATIONS FOR NATIONAL SECURITY PURPOSES, OR HOW AN INTERNATIONAL ORGANIZATION COULD PERFORM SUCH A MONUMENTAL TASK.

MOREOVER, WE SHOULD NOT OVERLOOK THE FACT THAT THE IAEA SAFEGUARDS SYSTEM IS A UNIQUE COMPROMISE OF SOVEREIGN RIGHTS BY MANY NATIONS, ONE WITHOUT PARALLEL IN ANY OTHER AREA OF NATIONAL SECURITY. IT SHOULD BE NO SURPRISE THAT THIS COMPROMISE IS SUBJECT TO CERTAIN LIMITATIONS.

AT THE SAME TIME DEFICIENCIES HAVE EXISTED IN THE IAEA'S CAPABILITY TO DETECT DIVERSIONS OF MATERIALS, ESPECIALLY IN THE ACTUAL IN THE-FIELD APPLICATION OF SAFEGUARDS. SUSTAINED EFFORTS BY THE U.S. AND OTHER INTERESTED COUNTRIES HAVE RESULTED IN SIGNIFICANT IMPROVEMENTS. HOWEVER, THERE REMAIN PROBLEMS AND WEAKNESSES WHICH REQUIRE FURTHER WORK TO IMPROVE THE IAEA'S EFFECTIVENESS AND TO KEEP PACE WITH NUCLEAR POWER DEVELOPMENTS. THERE STILL ARE, FOR EXAMPLE, PROBLEMS WITH THE RELIABILITY OF SURVEILLANCE CAMERAS, AND WITH THE RECRUITMENT AND RETENTION OF QUALIFIED INSPECTORS. TO ASSURE AGAINST SIGNIFICANT MISTAKES OR OMISSIONS BY STAFF IN THE CONDUCT OF INSPECTIONS AND ANALYSES IT IS IMPORTANT THAT ADEQUATE REDUNDANCIES AND CROSSCHECKS, SUCH AS WITH ESTABLISHMENT OF THE SAFEGUARDS EVALUATION UNIT, ARE BUILT INTO THE SYSTEM.

OVERALL, I WOULD LIKE TO EMPHASIZE THAT THE TOP MANAGEMENT OF THE IAEA IS HIGHLY COMPETENT AND MOTIVATED, AND THERE ARE MANY EXCELLENT AND COMMITTED STAFF AT ALL LEVELS. WE EXPECT THE NEW DIRECTOR GENERAL TO CONTINUE THE IMPROVEMENTS OF IAEA EFFICIENCY AND EFFECTIVENESS.

THE POLITICAL CONTEXT FOR IAEA SAFEGUARDS ALSO IS CRITICAL. THE DEGREE OF COOPERATION FROM INSPECTED STATES, ANY VULNERABILITY OF INDIVIDUAL INSPECTORS TO POLITICAL PRESSURE, ABILITY OF IAEA MANAGEMENT TO RESIST POSSIBLE PRESSURE FROM INSPECTED STATES ON SPECIFIC POINTS, AND GENERAL SUPPORT OF

SAFEGUARDS FUNCTIONS BY THE BOARD OF GOVERNORS ALL PLAY A PART. THE OVERALL SITUATION WITH REGARD TO SUCH FACTORS, ALSO IS GOOD. INSPECTED STATES, FOR EXAMPLE, GENERALLY ARE COOPERATIVE. IN THOSE CASES WHERE A STATE MAY NOT BE COOPERATIVE, THE DIRECTOR GENERAL CAN HAVE CONFIDENCE HE WILL BE BACKED BY A LARGE MAJORITY OF THE BOARD OF GOVERNORS. THE IAEA STAFF PERFORMS WELL IN TERMS OF REPORTING TO THE BOARD ON DIFFICULTIES ENCOUNTERED. THE IAEA SECRETARIAT ALSO IS ABLE TO RESIST PRESSURE TO DISMISS INDIVIDUAL INSPECTORS, AND THUS TO PROVIDE REASONABLE JOB SECURITY.

TURNING TO SPECIFIC BUDGETARY PROBLEMS WITHIN THE IAEA WHICH IMPACT ON THE EFFECTIVENESS OF SAFEGUARDS, THE ALLOCATION OF RESOURCES WITHIN THE IAEA BUDGET HAS BEEN A SUBJECT OF CONTINING DISCUSSION WITHIN THE BOARD OF GOVERNORS. AS YOU KNOW, THE BUDGET OF THE IAEA IS FUNDED THROUGH BOTH ASSESSED AND VOLUNTARY CONTRIBUTIONS, WITH THE MAJORITY OF TECHNICAL ASSISTANCE FUNDED THROUGH VOLUNTARY CONTRIBUTIONS. WITH REGARD TO THE REGULAR BUDGET, THERE ARE TWO DIFFERENT ASSESSMENT SCALES: ONE FOR SAFEGUARDS AND ONE FOR THE REMAINDER OF THE IAEA'S REGULAR BUDGET. IN SPITE OF THIS ARRANGEMENT, THERE CONTINUES TO BE STRONG SENTIMENT AMONG LESS DEVELOPED COUNTRIES FOR INCREASED TECHNICAL ASSISTANCE FUNDING, AND FOR STRIKING A MORE EQUAL BALANCE OF FUNDING BETWEEN TECHNICAL ASSISTANCE AND SAFEGUARDS.

WE HAVE STRONGLY OPPOSED INITIATIVES TO ALTER THE ASSESSMENT FORMULA FOR SAFEGUARDS FUNDING, AND HAVE ALSO ARGUED STRONGLY, AND TO DATE SUCCESSFULLY, FOR INCREASES IN THE IAEA'S SAFEGUARDS BUDGET. AS A COUNTERPART WE HAVE ACCEPTED SOME INCREASES IN TECHNICAL ASSISTANCE. INCREASES IN THESE TWO AREAS HAVE BEEN POSSIBLE ONLY BY EXERCISING RESTRAINT IN ALL OTHER AREAS OF THE IAEA BUDGET AND BY EMPHASIZING THE MOST EFFICIENT USE OF FUNDS IN ALL AREAS.

BECAUSE OF THESE CONSTRAINTS ON THE SAFEGUARDS BUDGET THE AGENCY HAS EXPERIENCED DIFFICULTIES IN FUNDING AN ADEQUATE NUMBER OF NEW INSPECTOR POSITIONS EACH YEAR TO KEEP PACE WITH THE LARGE INCREASE IN THE NUMBER AND COMPLEXITY OF FACILITIES UNDER SAFEGUARDS. EVEN SO, THE SAFEGUARDS STAFF HAS GROWN FROM 100 IN 1976 TO 220 IN 1981. FOR 1982, THE PROFESSIONAL SAFEGUARDS STAFF BUDGETED IS 228, OF WHOM 153 ARE INSPECTORS. SIMILARLY, THE SAFEGUARDS BUDGET HAS INCREASED FROM 6.4 MILLION DOLLARS TO 25 MILLION DOLLARS IN THE SAME PERIOD. THE REGULAR SAFEGUARDS BUDGET FOR 1982 HAS INCREASED BY 7.1 PERCENT AFTER INFLATION.

FUNDING SUCH A DRAMATIC INCREASE IN SAFEGUARDS APPLICATION ACTIVITIES HAS LEFT LITTLE MONEY FOR DEVELOPMENT OF NEW SAFEGUARDS EQUIPMENT AND TECHNIQUES. IT IS IN THIS AREA THAT THE U.S. PROGRAM FOR TECHNICAL ASSISTANCE TO SAFEGUARDS (POTAS) HAS BEEN CRITICAL. POTAS IS THE LARGEST EXTRABUDGETARY SOURCE OF SUPPORT FOR SAFEGUARDS IMPROVEMENTS AVAILABLE TO THE

IAEA. IN ADDITION, THIS PROGRAM HAS HELPED TO INDUCE OTHER COUNTRIES, INCLUDING THE UNITED KINGDOM, AUSTRALIA, GERMANY, CANADA, JAPAN, AND THE SOVIET UNION, TO INSTITUTE SIMILAR SAFEGUARDS ASSISTANCE PROGRAMS.

FUNDS UNDER THE U.S. PROGRAM FOR TECHNICAL ASSISTANCE TO SAFEGUARDS ARE ALLOCATED TO TASKS PROPOSED BY THE SAFEGUARDS STAFF OF THE IAEA WHICH HAVE BEEN REVIEWED AND APPROVED BY A U.S. INTERAGENCY TECHNICAL SUPPORT COORDINATING COMMITTEE. U.S. EXPERTISE AND TECHNOLOGY ARE TRANSFERRED TO THE IAEA; IN AREAS WHERE NEEDED TECHNOLOGY DOES NOT CURRENTLY EXIST, THIS PROGRAM ENSURES THAT IT IS DEVELOPED. IN PAST YEARS SUBSTANTIAL EFFORTS HAVE BEEN DEVOTED TO THE DEVELOPMENT OF NEW EQUIPMENT TO MAKE SAFEGUARDS INSPECTIONS MORE EFFECTIVE AND EFFICIENT. IN THE CURRENT FISCAL YEAR THE EMPHASIS IS SHIFTING TO PROVIDING THE TRAINING AND EXPERTISE NEEDED TO IMPLEMENT THESE IMPROVMENTS.

IN ADDITION TO OUR DIRECT SUPPORT TO THE IAEA THROUGH ASSESSED AND VOLUNTARY CONTRIBUTIONS, INCLUDING THE PROGRAM OF TECHNICAL ASSISTANCE TO SAFEGUARDS, SIGNIFICANT OTHER RESEARCH AND DEVELOPMENT ACTIVITIES TO SUPPORT INTERNATIONAL SAFEGUARDS AND U.S. NONPROLIFERATION ACTIVITIES ARE FUNDED THROUGH THE DEPARTMENT OF ENERGY, THE ARMS CONTROL AND DISARMAMENT AGENCY, AND THE NRC. THESE ACTIVITIES HAVE INCLUDED WORK ON EFFECTIVE SAFEGUARDS APPROACHES FOR GAS CENTRIFUGE URANIUM ENRICHMENT PLANTS, SPENT FUEL REPROCESSING PLANTS, AND FAST CRITICAL ASSEMBLIES; DEVELOPMENT OF A SMALL AIRCRASH-RESISTANT CONTAINER FOR SHIPPING PLUTONIUM SAFEGUARDS SAMPLES; TRAINING IN MATERIAL CONTROL AND ACCOUNTING, AND PHYSICAL SECURITY, FOR GOVERNMENT AND INDUSTRY OFFICIALS OF OTHER COUNTRIES; AND CONTINUED WORK TO DEVELOP TECHNICAL DESIGN OBJECTIVES FOR LIGHT WATER REACTORS AND FUEL FABRICATION PLANTS TO FACILITATE THE APPLICATION OF SAFEGUARDS.

THIS TYPE OF WORK ALSO PROVIDES THE TECHNICAL BACKUP NECESSARY FOR U.S. EXPERTS TO BE EFFECTIVE PARTICIPANTS IN IAEA SPONSORED MEETINGS OF CONSULTANTS AND ADVISORY GROUPS. THROUGH SUCH ACTIVITY, U.S. PARTICIPANTS HAVE BEEN ABLE TO INFLUENCE IAEA SAFEGUARDS POLICIES ON TECHNICAL MATTERS AND TO ENHANCE SAFEGUARDS EFFECTIVENESS. CONTINUED SUPPORT OF SUCH SAFEGUARDS R&D ACTIVITIES IS VITAL TO MAINTAINING THAT U.S. INFLUENCE.

MUCH REMAINS TO BE DONE TO MAKE INTERNATIONAL SAFEGUARDS MORE EFFECTIVE, AND POTAS WILL CONTINUE TO BE A CRITICAL FACTOR IN THE IAEA'S ABILITY TO MEET ITS SAFEGUARDS RESPONSIBILITIES. HOWEVER, BETTER EQUIPMENT IS NOT ENOUGH. AT THE SAME TIME THAT THE IAEA IS IMPROVING THE IAEA'S TECHNICAL CAPABILITIES, WE ALSO NEED TO ASSURE THAT STATES FULFILL THEIR SAFEGUARDS OBLIGATIONS AND PROVIDE THE DOMESTIC FRAMEWORK NECESSARY FOR EFFECTIVE AND EFFICIENT INTERNATIONAL SAFEGUARDS.

TURNING NEXT TO THE TECHNICAL PROBLEMS WHICH THE IAEA FACES IN APPLYING SAFEGUARDS ON REPROCESSING AND ENRICHMENT PLANTS, SUBSTANTIAL WORK DOES REMAIN TO BE DONE BEFORE SAFEGUARDS ON THESE TYPES OF FACILITIES REACH THE LEVEL OF EFFECTIVESS WE DESIRE. SUCH IS TO BE EXPECTED, WHEN THE IAEA HAS ONLY RECENTLY BEGUN TO APPLY SAFEGUARDS ON A FEW RELATIVELY SMALL FACILITIES OF EACH TYPE. I SHALL DISCUSS IN A MOMENT THIS IAEA EXPERIENCE TO DATE AND THE WORK UNDERWAY TO IMPROVE THESE SAFEGUARDS; BUT FIRST LET ME ADDRESS THE CONCEPT OF "TIMELY WARNING" AND THE AGENCY'S TIMELINESS OF DETECTION GOALS.

THE NUCLEAR NON-PROLIFERATION ACT ESTABLISHED THAT WHEN CONSIDERING FOREIGN REQUESTS TO REPROCESS U.S. ORIGIN SPENT FUEL, OR TO RETRANSFER THE DERIVED PLUTONIUM, THE SECRETARIES OF STATE AND ENERGY MAKE THE JUDGMENT THAT "SUCH REPROCESSING OR RETRANSFER WILL NOT RESULT IN A SIGNIFICANT INCREASE OF THE RISK OF PROLIFERATION BEYOND THAT WHICH EXISTS AT THE TIME THAT APPROVAL IS REQUESTED." THE NNPA FURTHER DIRECTS THAT "AMONG ALL THE FACTORS IN MAKING THIS JUDGEMENT FOREMOST CONSIDERATION WILL BE GIVEN TO WHETHER OR NOT THE REPROCESSING OR RETRANSFER WILL TAKE PLACE UNDER CONDITIONS THAT WILL ENSURE TIMELY WARNING TO THE UNITED STATES [EMPHASIS ADDED] OF ANY DIVERSION WELL IN ADVANCE OF THE TIME AT WHICH THE NON-NUCLEAR WEAPON STATE COULD TRANSFORM THE DIVERTED MATERIAL INTO A NUCLEAR EXPLOSIVE DEVICE."

THE SPECIFIC CONDITIONS FOR MEETING THIS STANDARD, HOWEVER, ARE APPROPRIATELY NOT ESTABLISHED IN THE LAW. THE TIME WHICH CONSTITUTES "WELL IN ADVANCE" AND THE MEANS FOR OBTAINING THAT WARNING WILL VARY DEPENDING ON SUCH OTHER CIRCUMSTANCES AS THE PRIOR PREPARATIONS OF A POTENTIAL DIVERTOR, THE LEVEL OF SOPHISTICATION OF ITS OTHER NUCLEAR ACTIVITIES, ITS ABILITY TO HIDE CLANDESTINE ACTIVITIES, AND THE QUALITY OF U.S. INTELLIGENCE. FURTHER, IAEA SAFEGUARDS CANNOT BE SPECFICALLY OR EXCLUSIVELY RESPONSIBLE FOR PROVIDING SUCH WARNING. IN MOST CIRCUMSTANCES WE WOULD HAVE OTHER, MUCH EARLIER, WARNING SIGNALS.

THE IAEA NONETHELESS, HAS ESTABLISHED CRITERIA TO IMPLEMENT THE OBJECTIVE OF NPT SAFEGUARDS, THAT IS "THE TIMELY DETECTION [EMPHASIS ADDED] OF DIVERSION OF SIGNIFICANT QUANTITIES OF NUCLEAR MATERIAL FROM PEACEFUL NUCLEAR ACTIVITIES." THESE CRITERIA ARE EXPRESSED AS GOALS FOR DETECTING DIVERSIONS OF SPECIFIED QUANTITIES OF MATERIAL IN A SPECIFIC TIME PERIOD. FOR REPROCESSING PLANTS, THE GOAL IS TO DETECT ANY DIVERSION OF 8 KILOGRAMS OF PLUTONIUM WITHIN ONE TO THREE WEEKS. FOR ENRICHMENT PLANTS UNDER SAFEGUARDS, ALL OF WHOSE DECLARED PURPOSE IS MAKING LOW-ENRICHED URANIUM, THE IAEA'S GOAL IS TO DETECT THE DIVERSION OF 75 KILOGRAMS OF URANIUM 235 WITHIN ONE YEAR. AT THE SAME TIME, OF COURSE, IAEA ENRICHMENT PLANT SAFEGUARDS ALSO MUST BE ABLE TO DETECT ANY MISUSE OF SUCH A SAFEGUARDED FACILITY TO MAKE HIGH-ENRICHED URANIUM.

ACHIEVING THE IAEA GOALS AT REPROCESSING PLANTS, ESPECIALLY THE TIMELINESS OF DETECTION GOAL, PROBABLY WILL REQUIRE DEVELOPMENT AND IMPLEMENTATION OF A DYNAMIC, NOT STATIC, MATERIAL ACCOUNTING SYSTEM. ONLY A CONTINUOUS ACCOUNTING SYSTEM, COMPARABLE TO INDUSTRIAL PROCESS MONITORING, WOULD PERMIT THE IAEA TO STRIKE A MATERIAL BALANCE AT SHORT NOTICE WHENEVER THE IAEA THINKS IT IS NECESSARY. EFFORTS TO DEVELOP THE TECHNOLOGY HAVE BEEN UNDERWAY FOR SEVERAL YEARS BOTH AT THE TOKAI MURA REPROCESSING PLANT IN JAPAN, AND AT BARNWELL, SOUTH CAROLINA. WE CONTINUE TO WORK WITH BOTH THE JAPANESE AND THE IAEA IN THIS AREA. CONTINUOUS INSPECTION DURING REPROCESSING CAMPAIGNS, SUCH AS NOW OCCURS, ALSO MAY BE NEEDED.

THE IAEA HAS BEGUN INSPECTING WITH PRELIMINARY TECHIQUES THE CENTRIFUGE ENRICHMENT PLANTS IN WEST GERMANY, JAPAN, AND THE NETHERLANDS. BUT ITS LONGER TERM SAFEGUARDS APPROACH FOR THESE FACILITIES STILL NEEDS TO BE AGREED UPON AND IMPLEMENTED. TO THAT END, WE ARE WORKING CLOSELY WITH OTHER COUNTRIES THAT HAVE CENTRIFUGE ENRICHMENT TECHNOLOGY AND WITH THE SAFEGUARDS INSPECTORATES OF THE IAEA AND EURATOM IN WHAT IS KNOWN AS THE HEXAPARTITE SAFEGUARDS PROJECT. THIS PROJECT IS DEVELOPING THE TECHNICAL BASIS FOR AN EFFECTIVE AND EFFICIENT SAFEGUARDS APPROACH FOR THESE FACILITIES. WE EXPECT ITS WORK TO BE COMPLETED WITHIN THE NEXT YEAR, RESULTING IN A SAFEGUARDS APPROACH WHICH SHOULD SATISFY OUR CONCERNS ABOUT THE PROLIFERATION RISKS ASSOCIATED WITH CENTRIFUGE ENRICHMENT PLANTS.

ON THE SUBJECT OF CURRENT POLITICAL TENSIONS WITHIN THE AGENCY AND THEIR IMPACT ON ITS EFFECTIVENESS, WE NEED TO RESIST THE INTRUSION INTO IAEA MATTERS OF EXTRANEOUS POLITICAL FACTORS, AS OCCURRED LAST SEPTEMBER WHEN THE GENERAL CONFERENCE DEBATED WHETHER TO SUSPEND ISRAEL FROM THE IAEA. SUCH POLITICIZATION ULTIMATELY COULD THREATEN THE ABILITY OF THE IAEA TO PERFORM ITS TASKS, AND ESPECIALLY ITS VITAL SAFEGUARDS MISSION. FOR NOW, HOWEVER, THESE DISPUTES HAVE NOT UNDERMINED SAFEGUARDS AND WE ARE GUARDEDLY OPTIMISTIC THAT A LARGE MAJORITY OF IAEA MEMBER STATES WILL CONTINUE TO RECOGNIZE THAT AN EFFECTIVE IAEA IS IN THEIR OWN SECURITY INTEREST AND IS AN INDISPENSIBLE REQUIREMENT FOR THE EXPANDED INTERNATIONAL NUCLEAR COMMERCE MANY OF THEM SEEK.

OTHER POLITICAL DIFFERENCES MORE DIRECTLY RELATED TO THE RESPONSIBILITIES OF THE IAEA ALSO CAN BE EXPECTED TO GENERATE CONTROVERSY BETWEEN THE DEVELOPED AND DEVELOPING COUNTRIES WITHIN THE IAEA. A FEW STATES ARE DISSATISFIED WITH THE EVOLUTION OF A SAFEGUARDS REGIME LARGELY FOUNDED ON THE NPT, WHICH THEY BELIEVE DISCRIMINATES AGAINST THE NON-NUCLEAR WEAPONS STATES. MANY DEVELOPING COUNTRIES FEEL THAT THE INDUSTRIALIZED WORLD DELIBERATELY RESTRICTS THE FREE TRANSFER OF PEACEFUL NUCLEAR TECHNOLOGY, WHILE ALSO BELIEVING THAT THEIR INTERESTS ARE SLIGHTED IN TERMS OF REPRESENTATION ON THE BOARD OF GOVERNORS, AND IN HIGH LEVEL AGENCY SECRETARIAT POSITIONS. FINALLY, AS DISCUSSED ABOVE, MANY DEVELOPING COUNTRIES BELIEVE THAT INADEQUATE RESOURCES ARE DEVOTED TO TECHNICAL ASSISTANCE RELATIVE TO THOSE DEVOTED TO SAFEGUARDS.

ON SUCH SPECIFIC ISSUES, WE MUST MAKE CLEAR FROM THE START OUR OPPOSITION TO CHANGES THAT WOULD UNDERMINE THE THE AGENCY'S EFFECTIVENESS. THUS, WE OPPOSED, AND CONTINUE TO OPPOSE, BOARD EXPANSION BECAUSE IT WOULD MAKE THE AGENCY'S GOVERNING BODY MORE UNWIELDY AND POLITICIZED, AND THEREFORE LESS ABLE TO MEET ITS RESPONSIBILITIES. WE ALSO OPPOSE TRANSFERRING THE FUNDING FOR TECHNICAL ASSISTANCE FROM VOLUNTARY FUNDING TO REGULAR BUDGET ASSESSMENTS, AN ACTION WHICH WOULD BE IN CONFLICT WITH OUR BUDGETARY POLICY. BUT WE ALSO SHALL SUPPORT REASONABLE CHANGES. FOR INSTANCE, THE US SUPPORTS DIRECTOR GENERAL BLIX'S ATTEMPT TO HIRE QUALIFIED CANDIDATES FROM DEVELOPING COUNTRIES FOR SENIOR IAEA POSITIONS AS THEY COME OPEN. WE ARE FULLY BEHIND IAEA INITIATIVES TO ESTABLISH TRAINING PROGRAMS FOR GOOD CANDIDATES.

THE INTERESTS OF DEVELOPED AND DEVELOPING COUNTRIES ARE NOT DIAMETRICALLY OPPOSED. THE EFFECTIVE IMPLEMENTATION OF IAEA SAFEGUARDS SERVES THE INTERESTS OF ALL COUNTRIES. NOR ARE THE DEVELOPING COUNTRIES A MONOLITHIC BLOC. THUS, AFTER THE GENERAL CONFERENCE LAST SEPTEMBER, WE TOOKS STEPS TO ESTABLISH A DIALOGUE WITH A NUMBER OF DEVELOPING COUNTRIES TO DISCUSS OUR RESPECTIVE INTERESTS AND CONCERNS IN A LESS CONFRONTATIONAL ENVIRONMENT. DURING THE RECENT BOARD OF GOVERNORS MEETING, I PERSONALLY MET WITH REPRESENTATIVES OF

A NUMBER OF SUCH COUNTRIES. NATURALLY SOME COUNTRIES HAVE BEEN LESS RESPONSIVE THAN OTHERS, BUT THERE APPEARS TO BE GENERAL AGREEMENT THAT EXCESSIVE POLITICIZATION OF THE IAEA IS UNDESIRABLE AND COUNTERPRODUCTIVE. AND IT IS A GOOD SIGN THAT AT THE MOST RECENT BOARD OF GOVERNORS MEETING THERE WAS MUCH LESS POLITICAL CONTROVERSY OF THE SORT THAT MARKED THE LAST GENERAL CONFERENCE. THE BOARD OF GOVERNORS CONDUCTED ITS BUSINESS WITH A MINIMUM OF EXTRANEOUS RHETORIC.

WE SHALL CONTINUE AND INTENSIFY THESE ATTEMPTS TO REDUCE POLITICAL CONTROVERSY, WHILE MAKING CLEAR OUR READINESS TO MEET THE LEGITIMATE CONCERNS OF THE DEVELOPING COUNTRIES AS WE APPROACH THIS YEAR'S GENERAL CONFERENCE IN THE FALL. SHOULD THE AGENCY BECOME INCREASINGLY POLITICIZED SO THAT IT CAN NO LONGER MEET ITS RESPONSIBILTIIES AND ESPECIALLY ITS VITAL SAFEGUARDS MISSION THE US WOULD BE FORCED TO REASSESS ITS ROLE IN THE IAEA. FOR NOW, THESE DISPUTES HAVE NOT UNDERMINED SAFEGUARDS. MOST IMPORTANT, WE BELIEVE THAT MANY OTHER COUNTRIES STAND READY TO WORK WITH US TO ENSURE THAT THE IAEA REMAINS AN EFFECTIVE INSTITUTION.

FINALLY, YOU ASKED THAT I DESCRIBE THE PROPER ROLE AND SIGNIFICANCE OF IAEA SAFEGUARDS IN OVERALL U.S. NON-PROLIFERATION POLICY.

AS PRESIDENT REAGAN SAID LAST JULY:

THE PROBLEM OF REDUCING THE RISKS OF NUCLEAR PROLIFERATION HAS MANY ASPECTS AND WE NEED AN INTEGRATED APPROACH TO DEAL

WITH IT EFFECTIVELY. IN THE FINAL ANALYSIS, THE SUCCESS OF OUR EFFORTS DEPENDS ON OUR ABILITY TO IMPROVE REGIONAL AND GLOBAL STABILITY AND REDUCE THOSE MOTIVATIONS THAT CAN DRIVE COUNTRIES TOWARD NUCLEAR EXPLOSIVES. THIS CALLS FOR A STRONG AND DEPENDABLE UNITED STATES, VIBRANT ALLIANCES AND IMPROVED RELATIONS WITH OTHERS, AND A DEDICATION TO THOSE TASKS THAT ARE VITAL FOR A STABLE WORLD ORDER.

AS I HAVE ALREADY SAID, ACCEPTANCE OF SAFEGUARDS IS IMPORTANT AS A SIGNAL OF A COUNTRY'S INTENTIONS. EFFECTIVE SAFEGUARDS ARE IMPORTANT IN VERIFYING THAT A COUNTRY IS IN FACT FULFILLING ITS INTERNATIONAL OBLIGATIONS AND IN DETERRING IT FROM FAILING IN THOSE OBLIGATIONS. BUT CRITICAL THOUGH IAEA SAFEGUARDS ARE, AS THE PRESIDENT'S STATEMENT INDICATES, THEY ARE ONLY ONE COMPONENT OF OUR NON-PROLIFERATION EFFORT. THE OVERALL PROBLEM REQUIRES A VARIETY OF MEASURES. THESE INCLUDE THE POLITICAL AND SECURITY RELATIONSHIPS TO WHICH THE PRESIDENT REFERS AS WELL AS INTELLIGENCE EFFORTS AND A RESPONSIBLE NUCLEAR EXPORT POLICY WHICH AVOIDS EXPORTS THAT MIGHT CONTRIBUTE TO ENHANCED PROLIFERATION RISK.

MR. CHAIRMAN, THIS ADMINISTRATION STRONGLY SUPPORTS THE IAEA. THIS UNIQUE INTERNATIONAL BODY PLAYS A MAJOR ROLE IN

OUR NONPROLIFERATION EFFORTS. WE HAVE TAKEN VARIOUS STEPS AND PLAN TO TAKE STILL OTHERS TO STRENGTHEN THE AGENCY AND TO ASSURE THAT IAEA SAFEGUARDS ACCOMPLISH THEIR OBJECTIVES. AND WHILE IMPORTANT PROBLEMS STILL NEED TO BE ADDRESSED, VERY IMPORTANT PROGRESS HAS BEEN MADE BY THE IAEA IN THE RECENT PAST. WE SHALL STRIVE TO MAKE THE AGENCY AN EVEN BETTER AND MORE EFFECTIVE ORGANIZATION, RECOGNIZING THERE ALWAYS WILL BE ROOM FOR FURTHER IMPROVEMENT. I WARMLY WELCOME THE PAST AND PRESENT INTEREST OF THIS COMMITTEE IN IAEA SAFEGUARDS, AND WILL WORK CLOSELY WITH YOU IN THE CONTINUED SUPPORT AND STRENGTHENING OF THIS ESSENTIAL ELEMENT OF OUR NON-PROLIFERATION EFFORT.

THIS, MR. CHAIRMAN, CONCLUDES MY PREPARED TESTIMONY, I WOULD BE PLEASED TO ANSWER QUESTIONS FROM THE COMMITTEE.

STATEMENT OF HON. ROGER KIRK, DEPUTY U.S. REPRESENTATIVE TO THE INTERNATIONAL ATOMIC ENERGY AGENCY

Mr. **Kirk**. Thank you very much. Let me first state that it is a great privilege for me to appear before you today to testify on issues related to the International Atomic Energy Agency.

The IAEA has an important mission to perform. It is a small, relatively lean organization which, I believe after nearly 4 years as the U.S. resident representative to the Agency, does a very creditable job. There are problems, and there is definite room for improvement, but my basic conclusion is that it is an organization which deserves continued U.S. support.

With your permission, Mr. Chairman, I will address the points raised in your letter inviting me to testify, speaking first to those which relate to the focus of safeguards efforts and to sounding the alarm when the IAEA cannot verify nondiversion. I will then move to the manpower and resource related questions.

ROLE OF IAEA SAFEGUARDS SYSTEM

The IAEA safeguards system exists because states allow an independent, outside authority to verify their adherence to certain specific commitments. This is a virtually unprecedented concession of sovereignty. For states to continue to grant it, they must be convinced that the IAEA will not discriminate amongst them on political grounds.

Nations differ as to which states are the most dangerous potential proliferators, but they virtually all agree that the IAEA does not have the ability, or the right, to make the judgment that a given country is not a potential proliferator.

It is critical to worldwide support of the safeguards system that the IAEA not be perceived as making such a judgment. This limits the IAEA's ability to focus its safeguards efforts on a restricted number of countries.

At the same time, the IAEA can, and does, focus its efforts on those facilities of greatest proliferation concern. Thus, it concentrates on those stages of the fuel cycle which involve "direct use" material, that is, material from which nuclear explosives can most readily be made.

It takes into account a nation's total fuel cycle capability and safeguards coverage when assessing the proliferation risk, and therefore the safeguards effort, at any given facility. Finally, the Agency has a special section for safeguards effectiveness evaluation which is responsible for identifying safeguards problems of special concern and for recommending measures to correct those problems.

DIFFICULTIES IN REPORTING DIVERSIONS

Now let me turn to the question of the difficulties of sounding the alarm when safeguards inspectors cannot verify the absence of a diversion of nuclear material from a plant under IAEA safeguards. Each year the Agency gives the Board a detailed, confidential report on its safeguards activities.

In every such report, the Agency has been able to state that it had enough information so that it considered it reasonable to conclude that the nuclear material under Agency safeguards remained in peaceful nuclear activities or was otherwise accounted for.

Last September, however, the Director General, for the first time in the Agency's 25-year history, informed the Board of Governors that the safeguards measures at a number of reactors—which included the Kanupp reactor in Pakistan—were such that he was unable to give this assurance. By doing this, the Director General did sound an alarm—not a finding of diversion, but a finding that he could not, in fact, adequately verify the absence of diversion.

He outlined the steps which IAEA planned to take to remedy this situation and received the support of the Board of Governors for his course of action. At the next IAEA Board of Governors meeting, in February of this year, the new Director General said progress had been made but that full implementation of improved safeguards had to be accomplished before the IAEA would be able to give the requisite assurance.

In discussing the issues raised in your letter regarding resources, Mr. Chairman, let me first stress a point which I know others have made and has been made by the speaker before; that is, that the purpose of IAEA safeguards is to help deter states from using their civil nuclear facilities for military purposes by detecting such a diversion and sounding the alarm.

The greater the chances of such detection, the better, but one does not need a 100-percent chance of detection to have the necessary deterrent effort. To have a 100-percent chance of detection is virtually impossible for any safeguards system, would place extraordinary burdens on the facility operator, and would require excessive resources for the IAEA.

The challenge that has faced the IAEA in recent years has been the great expansion of facilities and material under safeguards. In 1977, there were some 560 installations under IAEA safeguards. At the end of 1981 there were some 850 installations under safeguards, an increase of over 50 percent.

In part this reflects the growth of the use of nuclear energy. In large part, it reflects a welcome expansion in IAEA safeguards coverage. This coverage, incidentally, now includes some 98 percent of all nuclear facilities outside the nuclear weapons states. This expansion of safeguards needs has caused a resources pinch, growing pains in the IAEA's administrative structure, and a lag in IAEA safeguards coverage. It is important that the IAEA, with the support of its member states, take action to remedy these problems. I think a good effort is being made.

PERSONNEL REQUIREMENTS

Let me address the specific question of staffing and manpower raised in your letter. More inspectors are being hired. There were 130 professional inspectors on board at the end of 1981, as compared with 60 at the end of 1977. The Agency has started a program of using qualified General Services personnel to perform the routine inspection tasks, thus supplementing the professional inspector corps.

Recruiting and retention have also improved. Thus the Safeguards Department as a whole was at 90 percent of its authorized strength of 355 at the end of 1981, as compared to only 79 percent of the smaller authorized strength of 283 at the end of 1979. Those figures include both professional and nonprofessional personnel.

It is clear, however, that more needs to be done to build up an adequate career safeguards inspectorate. Last year the IAEA commissioned an independent study of the management practices of the safeguards department to this end. A number of its recommendations are now being implemented. In addition, a modest training program, to enable promising developing country personnel to qualify for the inspector corps, is being prepared by the new Director General.

There is a considerable way to go, but these efforts are bearing fruit. In 1979, the Agency accomplished only 39 percent of the agreed amount of inspection effort at the facilities under safeguards.

This had risen to over 50 percent in 1981. The IAEA expects it to go to about 60 percent in 1983, and the new Director General has made it clear that his overall objective is to acquire sufficient trained staff to raise this to 100 percent.

IAEA FUNDING

The resources devoted to safeguards in the Agency's budget have grown from almost $8 million in 1977 to a little over $25 million in 1982. This represents a real growth of over 97 percent. At the same time, the real growth in the budget as a whole was less than 25 percent, and the real growth of the voluntary technical assistance fund was some 27 percent. Tentative budgetary predictions for 1983 call for a 9.3 percent real growth in the safeguards budget as compared to 1983, a 2.5 percent real growth in the voluntary technical assistance target.

While most developing countries recognize their shared interest in nonproliferation, they note that the vast majority of nuclear facilities requiring safeguards are in the industrialized countries. They see their most immediate and concrete benefit from Agency membership as coming from its technical cooperation programs. They wish to assure that the funds for technical assistance grow at least as fast as those for safeguards. Therefore, they try to link the two.

There is, of course, no intrinsic connection between them. Safeguards expenses have grown, and will grow, because of the expansion of the number and complexity of nuclear facilities under the IAEA safeguards system. This has little, if any, direct relationship with the requirement, or availability, of funds for technical assistance. Therefore we have rejected and will continue to reject, any formal link between the two.

It is a matter of fact, however, that resources for technical assistance have grown rapidly since 1977—at the very time that additional powerplants were resulting in increased resources for safeguards. There is now a rough balance between the two when voluntary contributions are considered, and the 1981 General Conference resolved by consensus that progress in technical assistance should "keep pace with" progress in other main activities of the Agency. The developing countries attach great importance to this concept.

It will therefore be necessary, as we look beyond 1983, to permit continued growth in the funds available for technical cooperation if we are to gain members' support for the funds for an increasingly strong safeguards program. Not only that: The continued health of the Agency requires that both developed and developing nations believe that their interests are served by it; we must try to assure continuation of this belief.

This, of course, relates to the whole question of the ability of the IAEA to fulfill its safeguards responsibilities in an era of zero real growth in United Nations agencies. Substantial real growth in safeguards funding will have to continue if the Agency is to fulfill its responsibilities.

In recent years, this real growth has been achieved to a considerable extent by increasing efficiency in overall Agency operations and cutting down on other Agency programs. There are practical and political limits to this process, however. Other regular budget activities can only be trimmed so far. Furthermore, there will be the continued political need for growth in technical assistance funds. We will have to take these circumstances into careful account as we look at future Agency budgets and technical assistance targets.

STEPS TO INITIATE SAFEGUARDS IMPROVEMENT

Let me now turn to the last of the issues raised in your letter—the views of other IAEA member states on the need to improve safeguards and the steps these countries are taking to initiate safeguards improvements.

The need to maintain and improve safeguards effectiveness is widely shared by IAEA member states, even though, as I have noted before, many of them are more interested in the IAEA's technical assistance programs. Indeed, improved safeguards are regarded by many nations as a means of helping them demonstrate their compliance with their nonproliferation commitments.

Tangible evidence of the general support for improved safeguards is the fact that budgets containing much faster growth for safeguards than for any other regular budget item have regularly passed the Board and General Conference in the last several years. Tangible evidence of support for safeguards improvement by individual nations is their extra-budgetary contribution for that purpose.

In addition to the absolutely crucial U.S. safeguards support program of some $5 million per year, programs totaling some $6 million per year are being undertaken by Canada, the Federal Republic of Germany, the United Kingdom, Japan, Australia and the Soviet Union. These voluntary programs are a real demonstration of the importance these contries attach to the IAEA.

This concludes my prepared testimony, Mr. Chairman. Let me just say again, in conclusion, that I think the International Atomic Energy Agency, with all its imperfections, is worthy of strong support.

Thank you.

Chairman ZABLOCKI. Thank you, Ambassador Kirk.

Prepared Statement of Paul Leventhal, President, The Nuclear Club, Inc.

Mr. Chairman, I appreciate your invitation to testify at this joint hearing of the Subcommittee on International Security and Scientific Affairs and the Subcommittee on International Economic Policy and Trade.

The subject of the hearing—"to determine what steps are needed and being taken to ensure that our safeguards goals can be met" by the International Atomic Energy Agency (IAEA)—is crucial to two complementary sets of interests:

First, the U.S. national-security interest in assuring that American civilian nuclear exports are not diverted or stolen to produce nuclear weapons that can be used against us or to trigger a war that would engulf us;

Second, the global interest in assuring that nuclear violence does not erupt anywhere from conversion of commercial nuclear technology and materials to weapons purposes.

Unfortunately, neither interest is being served by the IAEA safeguards system. In fact, the IAEA safeguards system, so-called, is a dangerous misnomer. It is not "safe." It does not "guard" anything. It is not a uniform "system."

The IAEA is a unique experiment in international politics. It has made unprecedented strides in penetrating the sovereignty of nations to impose an international regime of inspections and audits on nuclear energy programs—one of the most sensitive areas of national prerogative. But because of the sensitivity and difficulty of its task, the IAEA has been subjected to a multitude of constraints that conspire to render its safeguards system dangerously ineffective and grossly misleading.

The weaknesses of IAEA safeguards have been methodically covered up, presumably to protect the agency from undue political pressure and embarrassment. In fact, the secrecy surrounding IAEA safeguards serve the other principal function of the IAEA—namely to promote nuclear power and research programs throughout the world. To quote authors Steve Weissman and Herbert Krosney in the recently published The Islamic Bomb, ". . . IAEA officials often sound as if they are more concerned to make the world safe for nuclear power than safe from nuclear weapons."

In fact, the IAEA safeguards system is fighting a losing battle against the spread of nuclear weapons. To the extent it promises more than it can possibly deliver; to the extent it has been used by nuclear advocates to provide a legitimate cover for what otherwise would be seen clearly as illicit trafficking in the means and materials needed to produce nuclear weapons, IAEA safeguards constitute "fraud." The extent of the fraud is only now becoming generally understood, as are the likely catastrophic consequences of the spread of nuclear weapons material and technology made possible by this gross deception of the public.

For years, we have been assured by a worldwide nuclear industry and bureaucracy that IAEA safeguards can and do provide an effective barrier between atoms for peace and atoms for war. Now we are coming to see that the only real barrier between peaceful and military use of the atom is the intent of the user. To quote NRC Commissioner Victor Gilinsky, "If we don't do something about the spread of nuclear-weapons material and technology we better tighten our seat belts because it is going to be a rough ride."

I am pleased to testify today on behalf of The Nuclear Club Inc. about what can be done and, more significantly, about what cannot be done to upgrade IAEA safeguards.

The Nuclear Club Inc. is a non-profit educational organization working exclusively on the "horizontal proliferation" problem—that is, the spread of nuclear weapons through commercial nuclear power and research programs. Our membership is a diverse group of citizens seeking to prevent civilian nuclear programs from following technological paths that will lead inevitably to development of nuclear weapons. The Nuclear Club seeks to coordinate the activities of other organizations that have an interest in the proliferation problem but cannot devote full time to it.

Previously, in staff positions in the U.S. Senate I was responsible for investigations and hearings and for drafting legislation leading to abolishment of the Atomic Energy Commission in 1974 and to enactment of the Nuclear Non-Proliferation Act of 1978. I also was Co-Director of the Senate Special Investigation of the Three Mile Island Nuclear Accident in 1979 and 1980. Much of my Senate staff work and current efforts through The Nuclear Club have been devoted to promoting public understanding of the incipient dangers of civilian nuclear programs in the absence of effective safeguards against illicit weapons development.

Out of these long-overdue hearings hopefully will emerge, first, a real-world assessment of U.S. options given the political and technical limitations of safeguards and, second, the realization that prohibition of commerce in nuclear explosive materials, not improved safeguards, is the key to curbing the proliferation of nuclear weapons.

At this point in my testimony, I will respond to the three questions you asked me to address in connection with the possible need for more restrictive U.S. export policies. I will then elaborate on some of the points made in these responses.

1. What kinds of nuclear facilities and materials is the IAEA unable to safeguard adequately?

The short answer is "all kinds." While the IAEA is better able to safeguard certain types of materials and facilities than others—for example, safeguarding spent fuel in light water reactors is a potentially manageable task while safeguarding plutonium once separated from the spent fuel is not—IAEA safeguards are currently inadequate across the board, given:

An IAEA inspection force that is understaffed, overburdened and beset by Third World and superpower politics.

A lack of support by IAEA-member nations for safeguards in relation to the agency's promotional role, which translates into a lack of financial and technical resources to fully implement and upgrade safeguards.

The political discretion of IAEA member nations to bar individual inspectors and to limit the access of those inspectors who are admitted.

The technical difficulties in making precise measurements of safeguarded nuclear materials and the absence of direct monitoring of the power levels of reactors to determine how much plutonium is actually produced in their cores.

The secrecy that surrounds IAEA safeguards arrangements in each country and the outcome of IAEA inspections and audits made pursuant to these arrangements.

The lack of uniformity of inspection and auditing procedures from country to country and from facility to facility within countries.

The general unreliability of containment and surveillance devices for detection of unauthorized movements of nuclear materials between visits by IAEA inspectors.

The absence of any police authority by inspectors to seek out clandestine activities or undeclared nuclear materials for the production of nuclear weapons.

The ease with which nations can renounce safeguards and other obligations under the Nuclear Non-Proliferation Treaty after acquiring all the materials and know-how needed to manufacture nuclear weapons.

The lack of prompt and effective international sanctions against an offending nation in the event the IAEA detects and announces a diversion of nuclear materials.

Given all of these weaknesses, it is unreasonable to expect that the IAEA can fulfill its basic safeguards objective. That objective is to detect on a timely basis, and thereby deter, diversions of civilian nuclear materials to weapons purposes; or to provide sufficient advance warning that a diversion has occurred to permit the international community to respond before clandestine nuclear weapons can be assembled and used.

The Nuclear Regulatory Commission now has the authority to withhold exports of low-enriched uranium if the recipient country intends to reprocess spent fuel and if the NRC believes that safeguards cannot be effectively applied to the separated plutonium. However, it appears unlikely that the NRC will take such bold action against the obvious preferences of the President and Executive Branch agencies, without a clear directive by Congress to do so.

It is incumbent upon this Committee and the Congress in general, therefore, to establish such a policy in law. This would be strong medicine, admittedly, but it may be the only remedy available to prevent a plutonium epidemic. Without such strong action by Congress, there is virtually no hope that the nuclear industry and bureaucracy in this country and abroad will voluntarily limit civilian nuclear development to the current generation of reactors and will forego reprocessing, plutonium recycling and deployment of breeder reactors.

Yet, only in the exercise of such technological restraint is there any hope that the IAEA safeguards system can "catch up" with nuclear development that already has taken place. Only by assigning the IAEA the task of safeguarding what is safeguardable is there any hope to prevent the spread of nuclear weapons.

Precious little time remains to avoid a world of nuclear anarchy and nuclear violence. What can still be done?

1. End secrecy: The weaknesses of the IAEA safeguards system must be openly acknowledged so that public pressure can be brought to bear to remedy them to the extent politically and technically feasible. The secrecy surrounding safeguards must be lifted.

Only in publicly airing the weaknesses and the limits of international safeguards is there any hope of strengthening the agency to the point that it can perform a limited inspection role effectively. Only in laying bare the technical and political limits of IAEA safeguards is there any hope to steer commercial nuclear enterprise away from technological paths that are unsafeguardable and, therefore, too inherently dangerous to be pursued for peaceful purposes.

There are technological and political means available to upgrade safeguards on reactor spent fuel. But there is no hope for developing effective safeguards on vast quantities of plutonium and high-grade uranium or on the reprocessing and enrichment facilities that produce these weapons-usable materials.

In this context, the Administration should explain the following confidential assessment of the safeguards system by the Department of Defense:

"DOD wishes to express its reservations about the effectiveness of IAEA safeguards, the weakness of the IAEA as an international institution, its susceptibility to Third World and East Bloc politics, its lack of an intelligence capability, and the limits of its scope and jurisdiction, in order to guard against undue reliance on the IAEA by those responsible for national security within the United States government."

The President's non-proliferation statement last July made no reference to this warning by the Department of Defense, although it did contain commitments to work for "an improved international safeguards regime" and to "seek to prevent the spread of nuclear explosives to additional countries." These commitments were offset, however, by the President's commitment not to inhibit plutonium reprocessing and breeder development abroad in advanced nations "where it does not constitute a proliferation risk," and later in his domestic nuclear policy statement, to promote reprocessing and breeder development in the United States.

It is difficult to understand how commercial reprocessing and breeder activities anywhere do not constitute a "proliferation risk" in the absence of effective safeguards. And if safeguards cannot be effectively applied now or in the future on separated plutonium, how can these advanced technologies be justified—especially when sufficient low-grade uranium, not usable in nuclear weapons, is available to meet the fuel needs of all the current generation of power reactors that are now operating or that can be built well into the next century?

2. Upgrade Safeguards on What Is Safeguardable: IAEA safeguards should be upgraded in facilities and on materials that are safeguardable. The IAEA should be split into separate and independent regulatory and promotional agencies—as was done with The Atomic Energy Commission.

Particular emphasis should be placed on improved containment and surveillance. In particular, the United States should press for the IAEA's acceptance and deployment of the advanced-technology "Operation RECOVER" and "Operation TRANSEAVER" systems. These systems, now being tested on a pilot basis, would permit satellite transmission directly to the IAEA, on a real time basis, of camera surveillance of nuclear facilities and shipments as well as the monitoring of electronic (fiber optic) seals. This system would represent a quantum leap beyond the present system of unescorted nuclear shipments and the labor-intensive, highly inefficient process of overburdened inspectors traveling from facility to facility around the world checking cameras that often do not work and antiquated seals that can be defeated.

In addition, a standardized IAEA materials accounting system should replace the myriad national accounting systems that IAEA inspectors somehow must oversee and verify.

The number of IAEA inspectors should be increased and the technical competence of the inspection force improved. It is scandalous that in an industry in which individual plants cost upwards of a billion dollars, the entire IAEA safeguards program is financed at $25 million a year, utilizing only about 140 inspectors to monitor over 700 facilities in 50 countries. In fact, figuring in a 20 percent turnover rate and sick leave, the actual number of available inspectors is about 100—at least ten times too small to fulfill the agency's own technical objectives.

3. Tighten U.S. Export Controls: The United States should assertively pursue a policy of withholding nuclear assistance and applying economic sanctions to nations that insist on pursuing reprocessing, enrichment and breeder development. The heart of a successful nuclear non-proliferation policy is the control of nuclear explosives—separated plutonium and high-grade uranium. The best way to control them is to provide leadership to bar their use in commercial nuclear programs.

PREPARED STATEMENT OF HON. NUNZIO J. PALLADINO, CHAIRMAN, U.S. NUCLEAR REGULATORY COMMISSION

It is a pleasure to testify before this joint hearing today on behalf of the Nuclear Regulatory Commission (NRC).

In your letter requesting the Commission's testimony at this hearing, you requested that our testimony discuss the (IAEA's) safeguards capabilities, technical problems hampering effective safeguards, NRC's efforts to improve them, and the role and significance of IAEA safeguards in overall U.S. nonproliferation policy.

The principal objective of IAEA safeguards, as defined in NPT agreements, is the "timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear devices or for purposes unknown, and the deterrence of such diversion by the risk of early detection." Values for the effectiveness parameter "significant quantity" and a range of values for "detection time" have been developed by the IAEA.

As the Commission has stated on a number of occasions, although we do receive substantial amounts of information of a more general nature, including some detailed information on the application of safeguards at some types of facilities, the NRC receives little specific information about the application of IAEA safeguards in particular countries or at specific facilities. Accordingly, as a general matter we do not know whether the IAEA is achieving its safeguards objectives in a specific country or at a specific facility. At the same time, we have enough information to be concerned that the IAEA safeguards system would not detect a diversion of significant quantities in a timely manner in at least some type of facilities. In addition, an NRC staff-sponsored study by Battelle Pacific Northwest Laboratories examined the inspection procedures and resources needed to satisfy quantity and timeliness detection goals essentially equivalent to the IAEA's technical objectives. While recognizing that there are large uncertainties in any such estimates, the study indicated that the IAEA's technical objectives may not be achievable for all facilities and all countries without substantial increases in IAEA inspection personnel and equipment resources.

In its November 27, 1981 letter to Congressional oversight committees, the Commission also noted that it is not confident that the member states of the IAEA would be notified of a diversion in a timely manner. As we stated in our March 2, 1982 letters to Congressmen Dingell and Ottinger and to Senator Hart, this is not to suggest that we believe a clear diversion would be covered up by IAEA officials. However, most situations will probably be quite ambiguous and the IAEA process for determining whether or not a diversion has in fact occurred may be time consuming. The Commission has been of the view for several years that more information on safeguards implementation should be reported to the Board of Governors.

In addition to the inspection resource limitations referred to earlier, there are a number of technical problems that impair the IAEA's ability to meet its safeguards objectives, especially at bulk handling facilities such as enrichment and reprocessing plants. The Commission notes that particularly difficult technical problems remain for the foreseeable future in meeting the IAEA's safeguards objectives in facilities possessing large amounts of, for example, plutonium, where a diversion of only a small percentage of the facility's throughput could make available sufficient material to fabricate one or more nuclear weapons. Appended to my written statement are additional remarks for the record which include an illustrative list of the specific technical safeguards problems faced at such facilities.

Notwithstanding these technical problems, many of which cannot be resolved in the short term, the Commission believes that safeguards have improved in recent years, and that efforts should be made to continue this improvement as rapidly as possible. To the extent that resources permit, the Commission is prepared to continue to assist the Executive Branch in strengthening IAEA safeguards. In this regard, the Commission has worked closely with the Executive Branch on a broad range of activities to improve international safeguards, including those efforts required by Title II of the Nuclear Non-Proliferation Act of 1978. For example, NRC participates in various interagency mechanisms which have been established to oversee various U.S. activities related to U.S. efforts toward improving IAEA safeguards. This includes the recently revitalized senior level Interagency Steering Group for International Safeguards, which is responsible for overseeing U.S. international safeguards policy. Finally, NRC has carried out a large number of activities having significance for improving IAEA safeguards. A detailed listing of these interagency and NRC activities is included in the additional remarks appended to our statement for the record.

Despite the current limitations of the IAEA safeguards system, it performs an essential role in support of our common nonproliferation goals and is an important element to be considered in the review of export applications. Nevertheless, we must not exaggerate its capabilities; it is intended to be an alarm system as was said earlier and not a system which is to physically prevent a government from diverting nuclear materials. Should a diversion take place, the U.S. and other responsible governments must then decide what political actions to take. IAEA safeguards are only one of many necessary components of the U.S. Government's nonproliferation policy, although a very important element in this policy.

Commissioner Ahearne notes that today's NRC testimony as well as our previous comments on IAEA safeguards reflect the difficulty a domestic regulatory body has in addressing international concerns.

Commissioner Bradford notes that recent developments profoundly illustrate the wisdom of Congress' choosing to have an independent agency review the licensing of nuclear exports.

This concludes our prepared testimony. We will be pleased to answer any questions you may have.

ADDITIONAL REMARKS OF NRC REGARDING IAEA SAFEGUARDS MATTERS

1. Technical problems affecting the safeguarding of bulk handling facilities by the IAEA.

Measurement instrumentation is inadequate.

Some measurement instrumentation and approaches have not been fully developed and field tested for some forms and types of material.

Measurement instrumentation that has been developed and field tested cannot be fully applied by the IAEA due to the lack of funding to purchase the instruments.

Operators' measurement programs and process conditions are not always conducive to independent IAEA verification of material quantities.

Facilities designed and built without safeguards consideration are sometimes extremely difficult to apply efficiently effective safeguards. This underscores the need to design facilities so as to facilitate the application of effective safeguards.

Surveillance devices, such as film and television cameras for bulk handling facilities, have limited reliability.

Some operators and States limit IAEA access to parts of their facilities.

In order to meet inspection goals, integrated safeguards systems which utilize cameras and seals, as well as material accountancy, are especially needed in reprocessing and enrichment facilities. Methodologies for quantifying the detection capabilities of the integrated systems remain to be developed.

2. Major interagency activities in support of improving IAEA safeguards.

The U.S. Action Plan—"Measures to Strengthen IAEA Safeguards (Action Plan)." The Action plan is a dynamic document which attempts to integrate ongoing U.S. activities and identify additional steps to improve the implementation of IAEA safeguards. Its actions are coordinated by an interagency group called the Action Plan Working Group.

The U.S. Program for Technical Assistance to IAEA Safeguards (POTAS). Established in 1976, POTAS is by far the largest extra-budgetary source of safeguards support available to the IAEA ($4.1 million in FY 82). Assistance is provided in five technical categories: equipment and standards; experts; studies; techniques, procedures, and equipment evaluation; and training. The U.S. Technical Support Coordinating Committee was established to oversee this primarily technical program.

The US/IAEA Agreement for the Application of IAEA Safeguards in the United States. This international agreement is the result of the offer in 1967 to accept international safeguards on U.S. facilities. Application of IAEA safeguards in the U.S. is a partial but important answer to concerns of nonnuclear weapon states regarding the discrimination which is inherent in the nonproliferation regime. In addition, the application of safeguards in U.S. facilities provides an opportunity to obtain a more thorough, working knowledge of the IAEA's safeguards procedures, and enable the IAEA to gain experience in safeguarding facilities that may have advanced material control systems.

3. Specific activities carried on by the NRC staff in support of improving IAEA safeguards.

Sponsored a technical objectives study to support development of U.S. positions on the goals of IAEA safeguards and the associated resource implications.

Sponsored related studies to identify design features which improve the effectiveness and/or efficiency of the application of IAEA safeguards at specific types of facilities (e.g., light water reactors, mixed-oxide fuel fabrication facilities, and reprocessing plants).

Assisted the IAEA in the development of safeguards evaluation by making NRC staff members available to consult on methodology and procedures for analyzing inspection results.

Assisted the IAEA in conducting an integrated information reporting exercise for a large low-enriched uranium fuel fabrication facility for developing a prototype reporting system.

Participated in the preparation of U.S. position papers for IAEA Consultants and Advisory Group Meetings which establish IAEA safeguards approaches.

Participated in the development and presentation of IAEA training courses for foreign officials and technical experts.

Assisted the IAEA in the development of a guide on States' System of Accounting and Control of Nuclear Materials.

Provided direct consultation and assistance to one country in the development of its national safeguards regulations for nuclear material accounting and control.

Participation on the steering committee for the TASTEX program to field test advanced safeguards instrumentation and approaches at the Japanese reprocessing plant at Tokai.

As a member of the Technical Support Coordination Committee, reviewed, approved, and monitored technical assistance projects supported by POTAS to meet the urgent safeguards needs of the IAEA. This includes the development and field testing of measurements instrumentation and surveillance devices for inspection utilization, the conduct of system studies to improve safeguards approaches, the establishment of the training programs and courses, and the transfer of safeguards technology and expertise through the provision of cost-free experts.

Cooperated and support the IAEA in the implementation of the US/IAEA Safeguards Agreement at NRC-licensed facilities.

STATEMENT OF EUGENE V. ROSTOW, DIRECTOR U. S. ARMS CONTROL AND DISARMAMENT AGENCY
(EXCERPT)

ADMINISTRATION COMMITMENT

Finally, there is an explicit commitment to the IAEA in this administration's nonproliferation policy. President Reagan has said:

> The United States will strongly support and continue to work with other nations to strengthen the International Atomic Energy Agency to provide for an improved international safeguards regime.

I hope, Mr. Chairman, this discussion of the key elements of our nonproliferation policy has provided a background for evaluating the role and significance of the international safeguards system.

I view nonproliferation in the framework of national and regional security. And I view IAEA safeguards as one of several essential elements in the overall nonproliferation effort, the others being international arrangements, diplomatic actions, export controls, and national technical means. I agree with IAEA's Director General Blix when he said on December 11, 1981, that "IAEA safeguards are measures through which the states, in the exercise of their sovereign will, rely upon an international organization to confirm through inspection that their actions conform to their stated intention not to acquire nuclear weapons," and that "the verification procedures should not be cosmetic but convincing."

DETERRENCE VALUE OF SAFEGUARDS

Where there is little doubt as to most countries' commitment to nonproliferation—and that is true in the overwhelming majority of cases—safeguards serve to reassure the international community of continued compliance with nonproliferation and other "peaceful use" undertakings. The deterrence value of safeguards is aimed at countries that might contemplate diversion of nuclear material or the misuse of a nuclear facility. It follows then that safeguards must be credible, and must be perceived to be credible.

IAEA safeguards do not prevent diversion. They do not serve to apprehend a diverter. They do not allow for searches for clandestine materials or facilities. They, obviously, do not deal with known nuclear facilities that are not under safeguards. In short, they do not address the whole of the proliferation problem. They are necessary but not sufficient.

In my view, it is just as wrong to overestimate the importance of safeguards in nuclear commerce as it is to denigrate the system for not accomplishing objectives for which it was not designed.

STRENGTHENING OF SAFEGUARDS

While much of the recent criticism of the IAEA seems to be based on misunderstandings about the role of the Agency within with nonproliferation regime, it is clear that the safeguards system needs to be strengthened. Continued U.S. efforts on safeguards improvements through relevant R. & D. and close interaction with the IAEA are essential. The nuclear fuel cycle is dynamic; safeguards should be equally dynamic. A great deal of ACDA's energy and imagination are devoted to this task.

We should exercise controls realistically and pragmatically on U.S. materials and technology in order to create and encourage a political climate in which all nuclear materials and technology can be responsibly used. And, our allies and the IAEA should join us in taking the steps necessary to meet the increased demands placed upon the IAEA safeguards system by the expanding nuclear fuel cycle.

ELEMENTS OF ENHANCED COOPERATION PATTERN

Specifically, I see three elements in this pattern of enhanced cooperation that I should emphasize in closing.

First, we need a renewed commitment by the member states to support effective and efficient IAEA safeguards. Voluntarily accepted by states for a variety of reasons, IAEA safeguards must be implemented in a cooperative rather than an adversary climate. For example, while IAEA must of course work within the established legal framework, differences in specific interpretations should be worked out promptly in the interest of effective safeguards and thus in the interest of the country concerned. The IAEA must be able to use cameras even if they are not provided for in an old safeguards agreement. Inspectors must be designated more promptly and without regard to factors not related to their duties. Every effort should be made to submit reports to the IAEA within set time limits. A country's system of accounting for nuclear material should serve effectively to support the activities of the IAEA, and not make them more difficult. Physical inventories of nuclear materials should be taken at the required times in order to provide credibility to the IAEA's accounting system.

Second, we need a strengthened commitment by the member states to provide the international safeguards system with the resources necessary not only to keep pace with the increased number of facilities but also to increase the ability of the Agency to apply effective safeguards at all facilities. For example, the member states must recognize that each nuclear export entails safeguards responsibilities for the IAEA, responsibilities which cost money for inspectors, equipment, and support staff. Each country needs also to support a sufficient number of qualified staff to deal with IAEA matters. And finally, it is essential that the member states develop the new equipment necessary to safeguard effectively and efficiently the additional and often more complex facilities since the IAEA must rely almost entirely on such voluntary assistance.

Third, we need a reaffirmed commitment by the IAEA to pursue its obligations in the most professional manner possible. For example, with due consideration to proper geographical distribution, IAEA safeguards staff should continue to be hired on their qualifications and promoted on their merit. The operation of a worldwide verification system must be supported by a strong base of modern management techniques, logistics and communications. And it should be recognized more explicitly by the IAEA that it provides a service on which the international community must be able to count. I do not agree with those who contend that an international organization is inherently incapable of providing such a service.

Mr. Chairman, many years of devoted effort have gone into the development of IAEA as an effective international agency. It is not perfect, but it is indispensably valuable. In examining the problem of nonproliferation, we must start by accepting the fact—and I believe it is a fact—that we can go forward only by building on what has been achieved already. Throwing out the baby with the bath water has never been a useful or an appealing procedure.

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PREPARED STATEMENT OF LAWRENCE SCHEINMAN, CENTER FOR INTERNATIONAL STUDIES, CORNELL UNIVERSITY

Chairman Bingham and Chairman Zablocki, it is a privilege to be able to participate in these hearings on a subject of vital importance to the international community, the international safeguards system of the International Atomic Energy Agency (IAEA). I have been asked to address three questions: what institutional problems confront the IAEA in carrying out its safeguards responsibilities; what measures might be taken within the framework of the existing system to ameliorate identified problems; and what additional institutional measures might be taken outside the system itself. In doing so, I will draw upon my understanding of the IAEA as a student of international organization and relations, and as a former member of the Ford and Carter Administrations in which I had policy-making responsibilities related to international safeguards and nuclear nonproliferation.

I

A proper perspective is essential to any meaningful discussion of international safeguards. Five points bear emphasis in this regard. First, the development and widespread acceptance of a system of safeguards which entail international verification of national commitments including on-site inspections is unprecedented in the history of the modern sovereign state. It is a significant development in international relations and an extraordinarily important event in the effort to move toward a stable and peaceful world order. Any assessment of international safeguards must take cognizance of this fact, not in order to justify or excuse identified weaknesses or deficiencies, but in order to understand the novelty of the situation, to appreciate the relationship between the states under safeguards and the implementing agency, and to be sensitized to the dynamics of the process of strengthening and improving the system.

Second, a large number of states in the international community are committed to international safeguards, and many influential voices beside that of the United States can be heard in support of them. Effective international safeguards are widely seen as essential to the health and vigor of international nuclear cooperation and commerce, and even though sovereign states do not particularly enjoy submitting their activities to international verification, a large majority understand that what matters in the final analysis is whether or not there exists a system in which there can be confidence.

Third, safeguards are not static, but evolutionary both in terms of substance and process. What constitute appropriate safeguards is a function of the facilities to which they attach and the fuel cycle in which those facilities are located. Safeguards have in the past and will in the future continue to change in response to changes in the number, character, and complexity of the facilities and fuel cycles to which they apply. This is an important, but not always appreciated consideration in judging the efficacy of a safeguards system.

Fourth, international safeguards do not of themselves constitute the nonproliferation regime. Rather, they are a part of that regime -- an admittedly crucial part -- and coexist with other norms, principles, practices and institutions which collectively form the regime. These include the belief, which lies at the heart of the Nonproliferation Treaty, that the proliferation of nuclear weapons is likely to be destabilizing and will not significantly enhance national security; the system of bilateral and multilateral agreements for cooperation with their terms and conditions for international exchange and commerce; the written and unwritten rules of cooperation as defined by those states which are in a position to offer nuclear assistance and supplies; and the system of international safeguards itself. While this would seem to be self-evident, the frequency with which critics of safeguards overlook the other components of the nonproliferation regime, and impose exclusively on international safeguards the entire burden of nonproliferation, compels a restatement of the point.

Fifth, international safeguards are neither systems of prevention nor of intelligence gathering in so far as searching out clandestine activities are concerned. Rather they are a means of monitoring compliance by states with their international undertakings with respect to peaceful nuclear development. Additionally, safeguards systems operate on the basis of probability, not certainty. All too often, however, prevention and certainty are introduced as criteria for judging efficacy. While certainty may never be attainable *a priori*, and should not be entertained as a criterion of judgment, efforts at prevention are a responsibility which fall elsewhere in the broader nonproliferation regime.

II

Turning to the question of what institutional problems confront the IAEA in carrying out its safeguards responsibilities there would seem to be no reason not to conclude that there exists in the Agency Statute and in INFCIRC 153 an adequate legal basis for the establishment and implementation of effective international safeguards. Greater uncertainty may exist with respect to INFCIRC/66/Rev. 2 although that too is debatable and a strong case can be made for its adequacy as a basis for effective safeguards. Such problems as the Agency encounters result not from an infirm legal base, but rather from political considerations some of which are endemic to international organizations and some of which are specific to the IAEA. We should not, however, be led to the oversimplifying conclusion that political factors will neutralize or undermine the establishment of effective international safeguards whenever they come into play; politics can work just as well in support of a strong and credible system as it can against one. Indeed, the entire history and evolution of safeguards can be viewed as a monument to how political factors can play a supportive and constructive role.

Many issues could be discussed under the rubric "institutional problems". I would like to consider four.

First, and perhaps foremost, the IAEA is an international organization and like all such institutions a creation of its clientele, the nation-states. International organizations are not co-equal with those states either in law or fact. They are not sovereign, and they are dependent on their member states for the resources by which they operate. These are all political realities and they condition the lives of international organizations. This underscores one inherent limitation in the IAEA -- it is an international bureaucracy that must deal with sovereign entities upon whom it is ultimately dependent, and cannot as a rule do so from a position of strength.

This is not to say that international organizations are totally lacking in ability to affect member-state behavior. For one thing the realities of any international organization include the fact that not only does the international bureaucracy face sovereign states, but sovereign states face one another with the Agency as a whole benefitting from the support of one or another group of states. For another, states may become strongly interested and even dependent upon opportunities created, or services performed, by international organizations. In these circumstances there may develop for the international bureaucracy a certain margin for initiative and action, an opportunity to induce certain support or behavior or to obtain certain concessions on the part of the state. In principle, the IAEA with its performance of the valued service of safeguarding, is in precisely this kind of position.

The potential for channeling or influencing state behavior notwithstanding, it is clearly the natural instinct of international bureaucracies and organizations to act circumspectly toward their member states. In the case of IAEA inspection and safeguards activities this could take the form of bending over backward to accommodate the safeguarded state, exercising undue patience in awaiting state reports, or giving the benefit of the doubt in marginal situations. It could and to a degree it almost certainly does.

Two conclusions certainly do not follow from this however: either that an actually detected diversion of safeguarded material would not be followed up by designated statutory procedures, or that clearly anomalous situations will be left unreported and without serious effort to achieve satisfactory resolution. What the Agency logically will seek to avoid are the dual risks of unnecessarily antagonizing states by raising false alarms with respect to their conduct and intentions, and of failing to sound the alarm when there does exist a reasonable cause to do so. Either outcome, but particularly the latter, would severely damage Agency credibility.

Confusion in this area tends to arise from two sources: first, the inclination to view the safeguards alarm system in dichotomous, "yes-no" terms when in fact the safeguards system in its entirety provides numerous points for alarm. Failure of a state to submit to safeguards in the first place is one source of alarm signalling to the international community that the reluctant state bears watching. Obstructionist or dilatory tactics by a state in negotiating safeguards agreements or facility attachments or agreeing to the designation of inspectors offers a second warning point, and the inability of the Agency to effectively implement safeguards and thus to be able to provide assurance that undertakings are being complied with represents yet another; and the existence of material unaccounted for another still. Additionally, this narrow approach to warning and alarm seems to be predicated on the erroneous assumption noted earlier that safeguards constitute the entirety of the non-proliferation regime and in doing so overlooks the role of cooperation agreements with their terms and conditions, national intelligence and the like.

Confusion also tends to arise from the inclination of some critics of the system to equate timely detection, the technical objective of NPT safeguards, with timely warning, a domestic US requirement and to infer from it an international requirement, which it is not. Even in our own legislation timely warning is to be given foremost, but not exclusive consideration, and other factors enter into an evaluation of the proliferation risk of exports and subsequent arrangements.

A second institutional problem is simply the newness and novelty of the international activity being carried on. In the course of the past eight months, stimulated by the Israeli vote of no-confidence in international safeguards in striking at Iraq's research reactor complex, a number of former members of the IAEA secretariat have testified before Congressional committees, including one of the present ones, regarding alleged deficiencies of the IAEA safeguards system. A broad range of subjects have been covered many of which relate to Agency implementation and follow-up procedures for the defining and handling of anomalous situations, standardization of practices; others focussed on deficiencies in the state systems of accounting and control of nuclear materials from which derive the records and reports which serve as a point of departure for IAEA independent verification, weaknesses in some of the safeguards agreements themselves, lags and delays in states reporting to the Agency, and inadequacies of resources in terms of manpower, money and equipment.

That problems of this nature exist and may intrude upon the efficiency and effectiveness of international safeguards system is certainly not surprising and probably inevitable. No less so however is the conclusion that the vast majority of these problems are not chronic and unalterable deficiencies, but amenable to diagnosis and correction. This is an example of what was meant in the earlier observation that safeguards are evolutionary, not static. The learning process undoubtedly has been accelerated by virtue of the attention being focussed on the efficacy of international safeguards in forums such as this one. That argues in favor of continued high visibility of international safeguards programs, their characteristics and their needs.

A third institutional problem that bears on the IAEA's ability to carry out its safeguards responsibilities is the fact that it is not exclusively a safeguarding agency, but must accommodate and be responsive to a wider array of interests. While, as noted earlier, many countries support the concept of international safeguards, participation in IAEA by third world countries in particular stems from the Agency's mandate to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world." For these countries, safeguards is a second-order interest which they support in exchange for technical assistance benefits they derive or hope to derive from Agency membership. Safeguards is not an immediate need for them although for many it may grow in importance as time goes on and neighboring country programs reach levels of capability where interests vest in maximizing information and in creating an atmosphere of confidence, trust and avoidance of weapons proliferation.

As long as safeguards and technical assistance (which in IAEA is funded through voluntary contributions) were supported in roughly equal proportions, third world concerns were relatively low key. However, during the period between 1976 and 1982 the proportion of the overall budget attributable to safeguards increased from 17% to 30% ($5.2 million to $25.7 million) while the technical assistance target increased only from 15% to 18% and was in fact stagnant for the six years preceding 1982. To the G-77 countries in IAEA this represented a dangerous if not untenable trend which they have sought to stem by seeking to place technical assistance funding on the same assessed budget basis as safeguards. Reasoning that the nuclear financial pie is only so large, and that if safeguards costs continue to escalate as they must if adequate resources are to be made available to the Agency, they have sought to foreclose an outcome detrimental to their principal interests. No matter that a not inconsequential part of the assessed budget is allocated to programs that contribute to developing country needs, that there is a considerable in-kind component to overall Agency technical assistance, or that a financing formula limiting absolute cost of safeguards to them was adopted a decade ago: skewing of Agency resources, regardless of how sourced, sharply in support of safeguards at the possible expense to technical assistance is to be resisted.

The risk to IAEA safeguards in all of this lies in its progressive politicization leading to systematic confrontations and a weakening of support for the safeguards program, an outcome that would be frankly applauded by some G-77 members such as Pakistan and India who have contributed to politicization of the technical assistance issue for their own narrow purposes. Of course, safeguards financing in fact is not out of line with its real needs and if anything is severely underfunded. This suggests the need to reassess not only the technical assistance program but how to deal with the cost of financing growing future safeguards requirements.

Mention also must be made of the Agency's Board of Governors. Historically, the Board has exercised legislative and executive functions although formally vested only with the latter authority. Membership has been based on a complex formula which, while seeking to achieve equitable geographic distribution, effectively ensures a permanent core of advanced states. For many years it was dominated by personalities drawn from the atomic energy community and dedicated to responsible Agency action in all fields of endeavor. These people have now been almost entirely replaced by a new generation which for many states are drawn from the ranks of those who reflect the kind of thinking that now dominates the United Nations General Assembly, and whose principal concerns are voting majorities, national secretariat quotas and technical assistance. They have led renewed efforts to enlarge the size of the Board to accommodate increased Middle East and African membership. The Board intervenes at numerous points on safeguards and the question must be raised of the possible impact of an expanded Board on the development and implementation of Agency safeguards not to speak of Board responses in the event that unresolved anomalies which could imply diversion were placed before it.

A fourth institutional problem, characteristic of all international organizations not only IAEA is the inability of the Agency itself to discriminate among the member states. The IAEA is not in a position to do significantly more than take cognizance of the fact that some states are more proliferation prone or less trustworthy than others in the way that a national supplier state can. Nondiscrimination does not mean that Agency cannot exercise to the maximum its safeguarding responsibilities in a suspect state which it presumably would do in fulfillment of its obligation to apply safeguards in order to verify compliance. Indeed the Agency has the right to safeguard material that comes under its jurisdiction and to refuse to apply safeguards if it feels that it cannot apply them in a manner that will enable it to meet its obligations.

It does mean that it cannot overtly concentrate a disproportionate safeguards effort on states just because it believes them less likely to abide by their undertakings. By the same token this means that countries like the United States must understand that there are limitations in how responsive the Agency can be to recommendations and suggestions for preferred strategies. In this context it is useful to remember that although the United States conceived the idea of the IAEA and was handmaiden at its birth, it no longer can claim parental rights.

III

This brief and necessarily selective review of institutional problems that could possibly affect the conducting of IAEA safeguards responsibilities makes clear that (1) inherent problems of international organizations need to be recognized and adjusted to in establishing the parameters of expected organizational behavior; (2) there are a range of implementation problems that relate to the internal structure and operational code of the secretariat and that are amenable to intraorganizational adjustment such as structural reorganization, cross-cutting review mechanisms to achieve standardization of analysis and response to identified problems, improved inspector training, improved personnel management practices and so on; and (3) the most important set of issues are those that involve Agency-State relationships, particularly with respect to the scope of State cooperation and accommodation to Agency defined requirements and the level of support to give to defined Agency needs. It is on this last set of issues that I would like to focus my attention.

There are no quick and simple solutions to problems deriving from Agency-State relationships; nor are they amenable to institutional fixes. I see four important institutional elements for an improved system without claiming for them either novelty, exclusivity or comprehensiveness. Safeguards must remain evolutionary and dynamic and therefore be dealt with through a constant procedure of incremental improvement and strengthening based on both technical and institutional adjustment and innovation. The four elements are: education; cooperation; confidence through increased transparency; augmented resources.

Education: For safeguards to achieve maximum effectiveness requires the full and complete support of the states to which they are applied. As some of the most astute members of the US arms control policy community have contended, that entails a basic change in attitude away from the perception of international safeguards as a necessary burden to be tolerated and toward the view that they provide an opportunity and a positive benefit that outweighs associated costs. By virtue of their voluntary submission to safeguards many states have at least tacitly admitted that safeguards positively contribute to their national interest. They don't like being monitored, but they like even less the idea that their neighbors might proliferate.

What hasn't been assimilated is the idea that the more unambiguous the conclusion drawn from a safeguards exercise on their nuclear program, the stronger their position is to seek comparable outcomes elsewhere. This, however, can only be achieved by optimizing the general information base regarding nuclear conduct and activity and this in turn entails a liberal, open and positively cooperative attitude and policy toward the application of international safeguards.

Jawboning about the merits of international safeguards and their contribution to national security will not alone be sufficient to bring about change. Ultimately what is needed is demonstrable proof that truly effective safeguards can be applied while respecting legitimate national sensitivities and legitimate concerns regarding genuinely proprietary information. One means for doing this would be for a country like the United States to go out of its way to expedite a really convincing application of international safeguards on a facility, or even range of facilities, and to document the exercise and publicize the results. This involves a liberalization of policy on information which will be discussed momentarily. In the last analysis, the overall system will rise to the level of efficacy that its clientele permit through their own efforts and policies. That level will depend substantially on attitude and perception regarding the benefits of having a totally clean bill of health and of inducing comparable behavior on the part of neighbors and the broader international community.

Cooperation: Much of what can be said about cooperation flows logically from what has been said about education and attitude. More specifically it relates to facilitating the application of safeguards measures and techniques; avoiding doctrinaire positions regarding classes of safeguards techniques or kinds of safeguards procedures; maintaining an open, positive and supportive view regarding the introduction of new techniques as they are developed; facilitating the effort to promote research and development in search of new and more efficient and effective safeguards instruments and approaches; the adoption by state authorities through the appropriate constitutional channels of administrative measures enabling closer and more direct state monitoring of facility operator compliance and cooperation with international safeguarding authorities in accordance with negotiated arrangements; upgrading of the state systems of accounting for and control of nuclear materials to ensure complete and timely reporting, appropriateness of records and the like; abjuring obstructionist behavior with regard to inspector designation and access; and facilitating optimization of safeguards through support for showcase efforts as suggested just a moment ago as a possible leadership action on the part of the United States.

Confidence through increased transparency: Safeguards systems are information systems, providing information regarding state behavior and serving as a basis for policy in states which factor that information into their national security planning. In democratic societies where public opinion plays an important role in helping to shape public policy, the public also assimilates that information. One of the difficulties in reaching informed judgments about state behavior elsewhere is the extent to which information is regarded as private, privileged and unavailable for public consideration. Problems related to confidence in the findings of the international safeguards system would seem to dictate the need for a reassessment of how to deal with the information base upon which assessments of compliance and the absence of diversion are made. This would seem especially timely in view of the increase in public testimony by acknowledged experts and former participants in IAEA safeguards regarding the alleged weaknesses and deficiencies of the system.

At least two kinds of information are involved: information at the state level, and information at the Agency level, that is to say information regarding the basic verification activities used by the Agency in making its independent assessment of state compliance. The statute of the Agency and the basic safeguards documents afford the state protection of privileged, proprietary and commercial information but do not extend this protection to the Agency itself.

At a minimum consideration should be given to the feasibility of creating greater transparency of Agency verification information. Such embarrassments as the Agency may suffer as a consequence of revealed deficiencies or weaknesses should be regarded as part of the learning process and the evolution of safeguards systems. But consideration also should be given to offering countries, on a systematic basis, the opportunity to have the results of Agency inspections published subject to the deletion of sensitive or proprietary material. There is virtually no proprietary information remaining in the realm of light water reactors for example, and that is probably true with respect to the vast majority of research reactors. A "graded transparency" system option might thus be introduced, perhaps on a trial basis, in order to ascertain to what extent such an arrangement enhanced confidence in verification activities and safeguards findings, and in order to identify possible problems posed for the inspected state. Here again the United States and/or other countries with priority commitments to international safeguards might offer leadership by example, volunteering greater transparency with regard to the arrangements for and results flowing form safeguards activities.

Augmented resources: The need for augmented resources in the form of financial support, manpower and equipment requires little commentary. It is not entirely a matter of pouring in resources however. Improved State-Agency cooperation through upgraded SSACs would permit more efficient use of existing Agency resources as would resolution of the issue of inspector acceptability: full employment of existing personnel can contribute to resource augmentation just as well as added funds. On the other hand the paucity of resources made available to international safeguards is striking when compared to the total cost of nuclear enterprise worldwide. Twenty-five or thirty million dollars loom large in the context of an eighty or eighty-five million dollar budget, but appears pitifully small when placed in the context of the objectives and expectations that the system is expected to serve.

The coupling of safeguards and technical assistance funding by a large portion of the Agency membership poses a serious political problem for meeting safeguards requirements without fully acquiescing in technical assistance demands, and underscores that the time has come to give serious consideration to alternative financing mechanisms for international safeguards in terms of economic cost, distribution of burden and political feasibility. A change in attitude, of course, could have a markedly positive affect on safeguards financing. If INFCE accomplished nothing else (a proposition I do not accept) it evoked a ringing endorsement of international safeguards and of the need to strengthen the system. The US contributes generously and disproportionately (e.g. POTAS puts between $4 and $5 million into R&D on behalf of the IAEA and this is about equivalent to what the balance of the Agency members contribute collectively off-budget). While the situation is improving with other countries dedicating talents and capabilities to improving safeguards much remains to be done, and a systematic campaign to that effect may be in order.

IV

Theoretically, international safeguards can be augmented outside the system in a number of ways none of which are mutually exclusive and elements of which always have been at play at least in some degree:

(1) their detection capabilities can be enhanced by national intelligence activities (for which, in some countries at least, international safeguards play a confirmatory role);

(2) the opportunities for diversion can be reduced or even removed, for example through the conversion of reactors using highly enriched uranium to reactors capable of operating effectively on fuels involving lower levels or enrichment, or through the establishment of regional, multinational or international arrangements for the conducting of sensitive activities or the storage of dangerous materials;

(3) incentives to violate international undertakings or to

withdraw from international commitments not to appropriate peaceful nuclear activities for military or explosive purposes can be reduced if not eliminated through the establishment of security arrangements including alliances, security guarantees, conventional arms support of nuclear weapon free zones.
Whichever of the strategies might be considered, it is clear that the value of institutional arrangements in support of international safeguards have become a part of the conventional wisdom on methods of reinforcing the nonproliferation regime.

Two kinds of approaches can be envisaged under the second point above: those which effectively constitute an extension of international safeguards, and those which go beyond the purposes of safeguards. An example of the former approach is the international plutonium storage (IPS) concept, provision for which can be found in the safeguards article of the IAEA Statute. Article XII A.5 provides that the Agency shall have the right "to require deposit...of any excess of any special fissionable materials recovered or produced...over what is needed (for peaceful purposes) in order to prevent stock-piling of those materials...." The IPS concept received in-principle endorsement in INFCE, but negotiations to consummate such an arrangement have thus far not been successful because of differences of view over such matters as who defines what is excess, how the release mechanism would function, and the issue of legitimacy of different end uses.

A carefully defined and well structured IPS could be a valuable reinforcement for the international safeguards regime. There are many considerations from a U.S. point of view regarding IPS such as the effect of such an arrangement on bilateral agreement rights over spent fuel disposition. One consideration worth bearing in mind is that over time the proportion of spent fuel falling under U.S. control will diminish and U.S. leverage regarding rules of the game for IPS, or even whether it would exist in lieu of national stockpiling of separated plutonium, will decline accordingly.

The second approach is reflected in multinational strategies. The concept of applying multinational institutional arrangements for sensitive fuel cycle activities is about as old as the nuclear age itself. However, political commitments and verification safeguards rather than organizational strategies of control predominated in the Atoms-for-Peace era. Since 1974 and the Indian detonation, interest in institutional arrangements more comprehensive than international safeguards have regained popularity. While multinational strategies may be regarded as an added dimension for detection of abuse of nuclear materials, they really address a different level of the problem - control over nuclear material and technology. As in the case of IPS, multinational approaches are confronted with problems of accommodation of different, if not competing interests which serve to put constraints on the opportunity of successful negotiation. They are, nevertheless, potentially crucial elements in an effective nonproliferation regime that will permit continued access to peaceful nuclear power on acceptable terms and without putting civilization at risk. And that is a common stake.

Thank you.

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TECHNICAL ASPECTS OF NUCLEAR NONPROLIFERATION: SAFEGUARDS

HEARINGS

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OF THE

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STATEMENT OF

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U.S. DEPARTMENT OF ENERGY

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
U.S. HOUSE OF REPRESENTATIVES

AUGUST 3, 1982

TECHNICAL ASPECTS OF NUCLEAR NON-PROLIFERATION: SAFEGUARDS

Madame Chairman and members of the committee, it is a pleasure to appear before you to discuss the "Technical Aspects of Nuclear Non-Proliferation: Safeguards". Prior to specifically discussing with you your questions concerning technical safeguards issues, I would like to briefly talk about the role of the Office of Safeguards and Security (OSS) in safeguards development. However, since your committee has an interest in nuclear non-proliferation, I will focus on our baseline technology development programs which benefit both the domestic and international sectors.

We provide direct and indirect technical assistance to the international safeguards regime managed by the International Atomic Energy Agency (IAEA). We provide direct support by managing the U.S.-funded Program of Technical Assistance to the IAEA funded by the Department of State in response to urgent and longer-term technology needs of that Agency. In addition, much of the technology which we develop for domestic application is transferred selectively to the IAEA and to international safeguards inspectors through training programs sponsored by the DOE. Direct support is also provided through the tracking of nuclear materials and independent physical security reviews of foreign facilities that have received U.S.-origin special nuclear material. Indirect assistance is provided through our participation with the Department of State, the Arms Control and Disarmament Agency, and the Nuclear Regulatory Commission in various technical working groups which provide support to the IAEA. Safeguards experts from several of our national laboratories participate on these working groups and provide the scientist-to-scientist interface which is invaluable in the transfer of safeguards technology.

I would like to address now the specific issues which you stated were of interest to the Committee.

Non-Destructive Assay and Containment and Surveillance

Our laboratories have been designing, building, fabricating, testing and installing instruments and equipment for the non-destructive assay of uranium and plutonium for about fifteen years. Typically, portable, easy-to-operate equipment is required for IAEA field inspections, whereas larger, more sophisticated in-plant equipment has been supplied for domestic use. For controlled measurement situations, such as fuel rods with well-defined geometries and material densities, non-destructive assay equipment can make assays to within 1 percent. For less well-defined situations, such as scrap and waste materials where container geometries and material densities are variable, measurement quality is less precise but often still adequate for effective materials accounting. In addition, measurement of such materials by non-destructive assay may be faster and as accurate as conventional destructive analyses.

Portable non-destructive assay equipment provided to the IAEA in the past five years by the United States under the program of Technical Assistance to IAEA Safeguards has, in general, been of high quality, reliable, and easy to operate. The major factors faced by the IAEA in getting the full use of this equipment have been the development of measurement procedures for the wide varieties of nuclear materials -- sizes, geometries, densities, compositions -- that are found worldwide; the availability of representative physical standards for calibration of the equipment; and the need for more thorough training of IAEA inspectors in the proper use of the equipment.

Now, I would like to discuss containment and surveillance technology. This technology has been developed primarily for international application, although it, like much international technology, finds its roots in our domestic safeguards program. Its utility in international safeguards arises from its capability to augment and to a certain extent relieve the requirement for on-location presence of inspectors and for routine and repetitive inspections at facilities such as nuclear power reactors or storage facilities where nuclear material inventories may be relatively static.

To date, in fact, most attention in this area has been paid to the use of surveillance equipment to maintain continuity of knowledge of spent fuel in storage pools at power reactors. We feel it is certain that additional important applications of surveillance equipment will develop; however, it appears that techniques currently employed will accommodate existing requirements.

Typical surveillance technology now in place includes 8-mm film cameras with large reels, mounted in tamper-indicating enclosures sealed by IAEA inspectors. The cameras take still photographs at pre-set intervals. Film is developed and reviewed by IAEA staff to insure that no abnormal activities have occurred since the last visit by IAEA inspectors. TV camera systems which operate over a much wider range of environmental conditions and have a capacity to store much more data have been developed and are in routine use by the IAEA. More advanced TV systems are under test and evaluation for use to supplement or replace the still cameras. We are working on more compact, advanced TV camera systems in close coordination with IAEA technical staff regarding operational and performance requirements for the system.

In the area of containment, our support program has also provided equipment and technology such as fibre optic and new metallic seals which can be used to verify that rooms, vaults or containers have not been broken into.

Scope, Mission Effectiveness, and Cost of Safeguards R&D Programs

The scope of DOE's domestic safeguards program relates to all of its nuclear materials and facilities, as well as to new power reactor concepts and related fuel cycle facilities. The general objective is to prevent successful malevolent acts involving nuclear materials and facilities. Tools of the integrated safeguards system include physical protection, material control, and material accountability activities to prevent theft, diversion, or sabotage of nuclear weapons, special nuclear materials, or vital equipment. In addition, DOE's U.S. national security responsibilities include technical support to nuclear non-proliferation objectives and international safeguards. In fulfilling these responsibilities and commitments, the Office of Safeguards and Security (OSS) sponsors research, development, tests and evaluations to improve safeguards effectiveness and correct specific deficiencies related to weapons development and production, nuclear materials production facilities, and nuclear energy development programs. The same safeguards and security technology base with adaptations, modifications, and spinoff provides substantial contributions to international safeguards.

The DOE/OSS-sponsored domestic R&D program is directed to designing, developing, demonstrating, assisting in implementation of (1) a strong physical protection subsystem of access and egress controls, barriers and intrusion detection alarm equipment to provide multiple obstacles between the material or vital equipment and a would-be thief or saboteur; (2) a reliable and rapid materials control subsystem to govern internal movement of material and monitor the status of process flows and inventories; and (3) an accurate and timely materials accountability subsystem to determine quantities of material in receipts, shipments and inventories, maintain records and perform data analysis and evaluation.

The R&D is carried out primarily by the Department's national laboratories (Los Alamos, Sandia, Lawrence Livermore, Oak Ridge) and other DOE contractors having expertise in the areas of concern. Areas of concern are based on specific needs identified by field offices and facility operating contractors, results of vulnerability studies and assessments, recognized shortfalls in existing equipment, and requested support to NRC, its licensees and the international community. A large portion of the total safeguards and security effort is directed to assisting field offices and facility operators in engineering design, development, procurement, installation, prototype testing, and operational evaluation of systems for specific DOE sites.

The effectiveness of the R&D programs can be measured in part by the acceptance of developed instruments and systems. The laboratories receive many requests for consultation in system design, prototype instruments and designs. In addition and as part of the technical assistance program, a comprehensive system evaluation capability is provided in direct support to improvement projects. Results are analyzed and integrated into a cohesive base to identify cost-effective and optimized designs to meet site-specific threats. This approach has been tested and is currently being successfully applied to several DOE sites.

The FY 1982 OSS budget for safeguards R&D and field assistance totals $22.5 M. The major elements of this program are approximately $10.4 M in physical protection and $8.2 M in materials control and accountability. Included in these amounts is $6.0 M funding for non-proliferation initiatives and support to international safeguards. This expenditure is focused on implementation of IAEA safeguards in the U.S. under the U.S./IAEA Agreement. The largest single effort is the development of safeguards concepts for application at the planned Gaseous Centrifuge Enrichment Plant at Portsmouth, Ohio.

International Safeguards Coordination

Coordination with other U.S. Departments and Agencies regarding these activities is on a continuing basis. For example, the DOE's New Brunswick Laboratory works closely with domestic and international users in providing analytical material standards (uranium and plutonium), as well as in developing chemical analytical methods.

Overall coordination with other U.S. Departments concerned with non-proliferation and safeguards is provided by regularly scheduled meetings of the Interagency Steering Group (ISG) for safeguards and subsidiary groups such as the Action Plan Working Group (APWG) and Technical Support Coordinating Committee (TSCC) which have representatives from the Arms Control and Disarmament Agency, Department of State, U.S. Nuclear Regulatory Commission, as well as my office in the Department of Energy.

Regarding international safeguards cooperation, the greatest single area is our work with the International Atomic Energy Agency (IAEA). The DOE's Office of Safeguards and Security has established at Brookhaven National Laboratory (BNL) an International Safeguards Project Office (ISPO) which receives, evaluates, and funds (if approved) specific R&D requests for instrumentation, equipment, and procedures. Daily coordination is assured by an ISPO staff member who is assigned as a resident representative at the IAEA.

In addition to coordination with the IAEA, we also work with EURATOM, the nuclear arm of the European Community. This coordination is effected through frequent visits by staff members, and by in-residence exchanges of EURATOM and U.S. laboratory scientific staff members.

Finally, we also cooperate on a bilateral basis with certain nations. Under existing U.S. bilateral agreements, we pursue joint R&D projects with nations such as Canada, the United Kingdom, West Germany and Japan.

We believe DOE/OSS now has an active and effective safeguards R&D and implementation program with other appropriate nuclear nations and international organizations.

Technology Implementation Problems

However, this technology implementation program is not without some difficulties. I am sure that the Committee members can appreciate some of the sensitivities which can arise when we are dealing with a complex mix of technical and institutional concerns in an international arena. None of these concerns has stopped us and our colleagues in other agencies from transferring the technical wherewithal which helps the IAEA perform its safeguards mission. But these concerns must be dealt with and are part of the costs of doing business. Let me be specific.

The implementation of advanced as opposed to basic safeguards technology can be hampered by a lack of awareness on the part of our intended customers within the IAEA and in foreign nations' nuclear safeguards programs as to just what technology is available to them. This concern is addressed through technical symposia, such as the just-completed annual meeting here in Washington of the Institute of Nuclear Materials Management and the meeting of the European Safeguards Research and Development Association (ESARDA) in The Netherlands. We also provide annual training programs specifically geared to the international audience at Sandia and Los Alamos National Laboratories. These are in addition to our extensive and continuing contacts through the Technical Steering Coordinating Committee which establishes priorities for technical assistance through the Program of Technical Assistance to the IAEA.

In addition to the possible lack of awareness of the availability of technology, there is a natural tendency on the part of operating facility managers to not want to disrupt normal operations through the addition of safeguards equipment. This can hinder the in-situ testing of safeguards systems if extensive installation efforts are required. However, complex safeguards systems have been successfully installed and tested once the cooperation of the host nation's government has been secured. Such cooperation is usually forthcoming when it is appreciated that some safeguards technology (surveillance cameras, for example) can reduce the frequency or extent of IAEA inspections and that, in general, the overall effectiveness of international safeguards is enhanced when newer, more effective technology can be installed.

Another concern which arises periodically is the setting of priorities for technology/implementation. Within the Department of Energy, we can and do work directly with program managers to establish priorities on technology implementation in the field. Priorities are established in accordance with the risks to national security which might be posed by malevolent acts against one of our facilities. On the international scene, however, we are institutionally separated from the technology users. We must, therefore, to a great extent, depend upon inputs from the IAEA staff and reflect their priorities in the development and transfer of safeguards technology. To date, IAEA priorities have tended to focus on the development of safeguards technology for application to bulk processing facilities and nuclear reactors. Their priorities have focused on two concerns. One is the continuing need for confident and continuous verification of nuclear materials on hand at each facility. The other is the need to make the most efficient use of a limited number of safeguards inspectors.

In addition to these institutional concerns, there are purely technical concerns which are addressed by our laboratories. These concerns include the need for complete documentation for available equipment, post-sale servicing of equipment by vendors, and the limited availability of specialized equipment. It also should be kept in mind that we are dealing with a very wide variety of nuclear materials in terms of the chemical and physical forms which must be measured and controlled. Hence, the technical issue of diversity of application is always present and must be dealt with. As a specific example, very different instrument geometries must be employed in the measurement of plutonium metal "buttons" as compared with a sample of plutonium nitrate liquid solution. On balance, the diversity of nuclear materials under safeguards worldwide does not pose insurmountable problems by any means. But it does require additional attention to the end use when instrumentation and other equipment is developed.

Long-Range Plans for Improving Equipment and Techniques

Long-range plans include greater emphasis on components and systems to solve deficiencies identified by comprehensive evaluations and to provide protection against insider and outsider threats of theft or sabotage at DOE facilities. Equipment to identify contraband (e.g., explosives) will be designed, fabricated and evaluated in operational environments of one or more DOE facilities. A broadened base of capability for measuring uranium and plutonium materials of different compositions and forms characteristic of advanced nuclear fuel cycles (e.g., Advanced Isotope Separations, breeder fuel) will be pursued to reflect the increasing need and benefits of automated, remote measurements in safeguarding nuclear materials.

An example of the type of long-range improvement is our assistance to the DOE field in the conceptual design and procurement of a central alarm and monitoring station for protective guard force response at a major production complex servicing several widely separated facilities at a DOE site.

Additional future improvements also include the need for preparation of an adequate and sufficient material standards reference base for calibrating non-destructive assay and chemical measurements across the fuel cycle. This includes expansion of safeguards-related measurement comparison programs and evaluation of proven non-destructive measurement technology.

Past support under the international program has included studies, preliminary concepts and vulnerability analysis, identification of safeguards options, and feasibility of applying advanced materials accountancy and containment and surveillance (C/S) technology. We have developed concepts for international safeguards for reprocessing plants. This involves support of efforts of the International Working Group Reprocessing Plant Safeguards. In addition, we have developed measurement and C/S devices to support safeguards options for a variety of fuel cycle facilities as examples of this support. Planned future needs include assistance to C/S programs for application of IAEA safeguards under the U.S./IAEA Agreement at DOE facilities selected for IAEA safeguards and to support commitments under the Nuclear Non-Proliferation Act of 1978. Efforts will be directed to assure that application can be accomplished in a realistic, effective and practical manner while protecting sensitive national security information and restricted data. This information includes the physical security and materials control and accountability plan for systems designs, the U.S. Gas Centrifuge Enrichment Plant, concepts for Advanced Isotope Separation, and for breeder fuel, storage and reprocessing. Specialized techniques and equipment will be reviewed to monitor process material flows, transfers, and inventories within bulk fabrication and processing facilities, including unique methods for identifying the composition and verification of fuel elements held in storage and transfer.

Conclusion and Summary

I have discussed quite a list of safeguards programs and issues. I would like to conclude by stating that we are doing what we can to provide effective safeguards on our own nuclear materials while supporting a credible international safeguards regime. We are doing this through our baseline technology development programs which benefit both domestic and international sectors. We are coordinating with other agencies, both international and within the Government, to establish appropriate priorities and avoid duplication of effort. Finally, we are working to resolve issues which could hamper effective safeguards both at home and abroad. I don't claim that these systems are perfect, only that they are credible and we are working to make them better.

I would be pleased to entertain any questions you may have at this time.

STATEMENT

By

L. MANNING MUNTZING, President
AMERICAN NUCLEAR SOCIETY

"TECHNICAL ASPECTS OF NUCLEAR NON-PROLIFERATION: SAFEGUARDS"

Before

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U. S. HOUSE OF REPRESENTATIVES

August 4, 1982

Chairman Bouquard and Subcommittee Members:

My name is L. Manning Muntzing, President of the American Nuclear Society (ANS), located at 555 North Kensington Avenue, La Grange Park, Illinois 60525. The ANS, founded in 1954, is a not-for-profit scientific, technical and educational Society of 13,000 scientists, engineers and educators from universities, government and private laboratories and industry. We appreciate the invitation to participate in these hearings on the "Technical Aspects of Nuclear Non-Proliferation: Safeguards".

The American Nuclear Society formally states its positions by the use of Public Policy Statements that are the considered opinions and judgments of the Society in matters related to nuclear science and technology. These Public Policy Statments are intended to provide an objective basis for weighing the facts in reaching decisions on important national issues. Attached to my testimony is a Public Policy Statement of the ANS entitled "United States Post-International Nuclear Fuel Cycle Evaluation (INFCE) Policy" dated September 1981. Two recommendations from that Policy Statement are particularly relevant to these hearings:

1. The ANS recommends that the Administration take the steps needed to define its program for improving internationally acceptable safeguards and demonstrating application and surveillance of such safeguards through the International Atomic Energy Agency (IAEA).

2. The ANS further recommends that the United States Government, in close cooperation with the nuclear industry, take the initiative in establishing regional, international, or multinational institutional solutions for sensitive fuel cycle services that would provide supply assurance to all nations at reasonable cost for such services.

The conclusions of the American Nuclear Society in this position paper are as follows:

1. The concerns regarding proliferation can now be resolved with international cooperation on safeguards and the development of appropriate institutional arrangements through the leadership of the United States.

2. The United States should take a necessary step to restore the domestic nuclear option by accepting and implementing the findings of INFCE.

3. The Government should also take the actions recommended to restore credibility and leadership in international nuclear policy as a reliable supplier and in safeguards development by signaling attention to the INFCE results and acceptance of the INFCE findings.

The INFCE findings supported by the ANS relating to safeguards include the following:

1. INFCE concluded that "Proliferation is primarly a political, and not a technical, matter" and that international measures already exist to reduce the risk of proliferation.

2. INFCE minimized concerns regarding the use of the commercial nuclear power fuel cycle as a route to proliferation. The evaluation stated, "The construction and planned misuse of fuel cycle facilities is not the easiest nor the most efficient route to acquire materials for the manufacture of nuclear weapons" and that, "The use of commercial grade plutonium is an unattractive route to the manufacture of nuclear weapons as compared with weapons grade plutonium produced by a dedicated program."

3. INFCE found with respect to fuel cycle services that, "means exist to minimize the danger of misuse of fuel cycle facilities - including technical measures, improved safeguards, and institutional arrangements."

4. Technical measures by themselves have only a limited ability to reduce proliferation risk. However, institutional arrangements were seen as contributing importantly to minimizing proliferation risks and to establishing assurance of supply.

5. INFCE concluded that improved safeguards can minimize proliferation. This view was expressed in the following observations:

"Further development and improvement of existing methods and techniques were foreseen as necessary to meet safeguards objectives at reasonable costs, in connection with technologies for uranium enrichment, industrial-scale reprocessing or irradiated fuel, and mixed oxide fabrication for LWRs or breeder reactors.

"For future reprocessing and mixed oxide fuel fabrication plants it will be essential to take full account of criteria for effective international safeguards."

The above testimony reflects the official position of the American Nuclear Society. It is, however, possible to add to these basic concepts by way of example and description. The discussion that follows, therefore, is not part of the official ANS position, but it is my belief that it is consistent with and illustrative of the general principles officially approved by our Society.

Non-proliferation objectives can be achieved through a combination of institutional arrangements, safeguards and technical measures. While the statements that follow emphasize safeguards and technical measures, institutional arrangements are particularly important and should not be deemphasized. The IAEA has under consideration a variety of initiatives. In addition, ideas such as the leasing of nuclear fuel could also contribute to non-proliferation objectives.

In order for the institutional systems to function effectively, however, it is essential that there be a credible safeguards system. The International Atomic Energy Agency has established a system of safeguards designed to assure that nuclear materials are being used only for civilian purposes. Supporting that program are measurement equipment and verification techniques.

During the past decade there has been a substantial effort worldwide in research and the development of new instrumentation and techniques for verifying the identification, location, and quantity of materials. As a result, there is now a need for extensive applications engineering, in consort with the operators of facilities, to assure practical application of the instrumentation in all countries. For instance, the proposed expanded tests at Barnwell could add significantly to our knowledge on the use of advanced safeguards technology. Further, there is a great need for the establishment and support of an infra-structure for the maintenance and repair of instrumentation. Of particular importance is the development of reliable sources for spare parts. Regardless of how effective an instrument may be, if it cannot be relied upon, if its repair is not simple with readily available spares, it will gain little acceptance by the inspectors and see little application.

There is a continuing need for miniaturization of equipment. Inspectors have commented that it is difficult to take into the field all the equipment which is available to them. If the function of the instrumentation can be incorporated into smaller, light weight, rugged containers without compromising the sensitivity and reliability of the instrumentation, it will obviously improve the acceptability and utilization of the equipment.

Proper training is also an important ingredient in the application of the techniques and equipment which have been developed. There needs to be more emphasis and attention devoted to training at the International Atomic Energy Agency, particularly under realistic circumstances. Inspectors need to be trained on the equipment in real environments under typical field conditions. There have been developed new training methodologies which the Agency should adapt to its programs. This is particularly important at the IAEA because of the high turnover of inspectors.

Typically, the assignment of an inspector to the IAEA is for a two year period with the possibility of an extension. It generally takes about a year for the inspector to become accustomed to his role as an inspector and he may not become fully efficient or effective in his role until he nears the end of his second year, at which time he is preparing to leave the Agency. The Agency should review its policy of short term appointments and explore the desirability of longer term appointments for inspectors.

Ideally, there should be established an academy for prospective inspectors to provide them with a good and common foundation with regard to the use of safeguards techniques and equipment. The curriculum should include frequent trips into the field to apply the knowledge imparted under realistic circumstances. Upon graduation from the academy, the prospective inspectors should be given an appointment of sufficient length that the investment by the IAEA can be reasonably amortized. An appointment of at least five years seems reasonable in order for the Agency to take full advantage of the training and experience that the inspectors gain.

Standard reference materials are needed for calibration of field and laboratory equipment, and to support quality control and quality assurance programs. Not only is there a need for standards development, but equally important is a need for a reliable supply program so that the standards can be used. In the past there has been an inadequate support for standards programs. Domestically, there have been occasions when the lack of a supply of standard reference materials has adversely affected the domestic safeguards program. Licensees have had to ask for waivers from the Nuclear Regulatory Commission of quality control requirements because standard reference materials were not available. Typical of the lack of support for standards programs is the UF_6 Artifact Standards program which is currently languishing for lack of financial support.

There is also a need for standardization in the manner in which data is generated, aggregated, and processed. Today there is a flood of data into the IAEA; but, because there are not adequate standards applicable to its generation, there is extreme difficulty in analyzing the data in a meaningful manner. Without standardization, comparisons can be meaningless and analyses can be misleading. Even under the common code of regulations of our domestic programs, there is a recognized need for standardization in the development of data and consistency in the analysis of that data. At the IAEA, standardization needs to start with the Facility Attachments*, and each facility needs to be encouraged to produce its data in a common, consistent format using standardized procedures.

The IAEA needs encouragement to further its surveillance and containment program. In support of that program, there is a need for the development of improved integrity and reliability including redundancy of surveillance devices such as cameras. Storage and retrieval of the information needs to be improved so that the information can be acquired in an easy and timely manner. Although effective security seals presently exist for many applications, a major effort is needed to develop a new generation of rugged and inexpensive seals which can reliably operate in hostile environments such as fuel assemblies in an operating reactor. Of utmost importance is simplicity of attachment and ease of verification.

*The Agreement between the IAEA and the owner of the facility to be inspected.

To discuss the needs of the safeguards program of the International Atomic Energy Agency is not to denigrate in any fashion the accomplishments of the Agency or to minimize the importance of its current activities. Establishment of the IAEA was a significant accomplishment in international relations. Moreover, the IAEA safeguards program is unique because it requires sovereign nations to open their nuclear facilities and records to international inspection, a concession which is unparalleled in history. That so many nations of the world have accepted reliance upon the Agency's safeguards program is indeed a noteworthy accomplishment.

Unfortunately, much of the inspector's activities and the results of inspections are cloaked in secrecy, a fact which undermines the credibility of the safeguards program. The IAEA Safeguards Program can provide a window on the utilization of nuclear materials in participating nations. Each nation should recognize that fact and should take advantage of that window to display its good intentions for the world to see. Consequently, we should be encouraging all nations to reassess their demands for secrecy with regard to the Agency's activities and to encourage an open record of those activities. At the same time, nations may have commercial information which they wish to protect. Therefore, progress toward application of safeguards in an effective manner at the perimeter of facilities is a desirable goal. Achievement of this goal may convince some nations to place under IAEA safeguards facilities which contain such information.

The improvements to the IAEA program described above will enhance the IAEA ability to detect diversion or changes in normal operation. As such they constitute a restraint to the civilian nuclear power program being a source of nuclear weapons material. In addition to the safeguards system and their effective implementation, it has been suggested that non-proliferation objectives could be further achieved through research concerning technical measures, such as supplying fresh fuel in a "denatured" fashion so that diversion is further discouraged. This was the purpose of the CIVEX proposal made several years ago.

Another concern is in a "twilight zone" between institutional and technical arrangements. This involves the issues associated with resource accumulation of "dual use" materials. These are areas where useful research and analysis could further contribute to non-proliferation objectives.

Supplier nations have cooperated to a substantial degree in identifying items which should be subject to export controls. To date, however, the lists of restricted items have generally included only those materials, components or technologies which are clearly intended for use in sensitive nuclear facilities. In recent years much attention has been given to presumed efforts by some nations to import uncontrolled items which, in addition to their normal innocuous uses, can also have use in enrichment or reprocessing plants.

Some of these "dual use" items are so common that it would be virtually impossible to subject them to meaningful control. This may not be true of all, however, and supplier nations should make a determined effort to identify those commodities which have a clear application in sensitive nuclear facilities and for which controls may be feasible. Failure to make this effort would leave the supplier nations open to the criticism that they have turned a blind eye to an important proliferation problem.

A combination of improved safeguards and effective implementation, attention to technical constraints and institutional arrangements can assure that peaceful nuclear uses do not contribute to nuclear weapons. This means that programs must be conducted so that the risks associated with peaceful uses, whether they be risks to health, safety and the environment, or risks related to weapons proliferation, are contained at very low levels and perceived by the public to be acceptable.

Even with technical solutions, safeguards controls and institutional arrangements, a fundamental point that must be kept in mind is that the most important step to peace and stability throughout the world is to remove the motivation for war. One such possible motivation stems from the fact that nature did not distribute oil, gas, coal or uranium evenly around the world. Most nations do not have sufficient energy sources of their own. One of the ways to remove this motivation for war is to have assured supplies of energy. Nuclear power, rather than being a contributor to war, will help to achieve peace through providing energy to resource deficient countries.

A good bargain has been reached in the world between nuclear weapons and non-weapons nations, namely, that nuclear weapons are to be controlled and reduced while nations receive peaceful nuclear benefits. It is the renowned concept of "swords into plowshares". In addition, peaceful nuclear benefits can help remove one of the motivations for war and be a force for nuclear weapons control. The anti-nuclear weapons forces should be in the forefront of those advocating peaceful nuclear uses and the supporters of peaceful uses should support controls and reductions of nuclear arsenals.

BIOGRAPHICAL SUMMARY

L. MANNING MUNTZING

Born Harrisonburg, Virginia, June 24, 1934. Admitted to the District of Columbia, Maryland and West Virginia Bars 1960. Preparatory education, University of North Carolina (A.B. 1956), Phi Beta Kappa; Woodrow Wilson School for Public and International Affairs, Princeton University; Harvard University Law School (LL.B. 1960). Counsel, Chesapeake and Potomac Telephone Companies 1960-71; Director of Regulation, United States Atomic Energy Commission, 1971-75. Member: Editorial Advisory Board, Progress in Nuclear Energy, International Review Journal, 1976 - present. Member: Board of Trustees, National Presbyterian Church, 1977 - present. Member: the Bar Associations of the District of Columbia, State of Maryland, State of West Virginia, Federal Bar Association (Chairman: Atomic Energy Committee 1975-76; Council on Science, Technology and the Law Section 1976-79), and the American Bar Association. Member: American Nuclear Society, Board of Directors and Executive Committee, 1977-81; President 1982-83; ASTM (Member, Research and Technical Planning Committee 1976 - present, Chairman, 1978 - 80). Editor of INTERNATIONAL INSTRUMENTS FOR NUCLEAR TECHNOLOGY TRANSFER.

STATEMENT OF ALLEN L. SESSOMS
ACTING DIRECTOR, OFFICE OF NUCLEAR
TECHNOLOGY AND SAFEGUARDS
U.S. DEPARTMENT OF STATE

before the

SUBCOMMITTEE ON ENERGY RESEARCH AND
PRODUCTION, COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

on

TECHNICAL ASPECTS OF NUCLEAR NON-PROLIFERATION: SAFEGUARDS

AUGUST 3, 1982

MADAME CHAIRMAN:

THANK YOU FOR THE OPPORTUNITY TO APPEAR BEFORE THIS SUBCOMMITTEE TO DISCUSS CERTAIN TECHNICAL ASPECTS OF SAFEGUARDS OF THE INTERNATIONAL ATOMIC ENERGY AGENCY SAFEGUARDS SYSTEM. YOUR LETTER OF INVITATION IDENTIFIED A NUMBER OF ISSUES IN WHICH THE COMMITTEE HAS EXPRESSED INTEREST, INCLUDING: THE ADEQUACY OF PRESENT NONDESTRUCTIVE ASSAY EQUIPMENT AND CONTAINMENT AND SURVEILLANCE DEVICES; THE SCOPE, EFFECTIVENESS, AND COST OF THE STATE DEPARTMENT'S RESEARCH AND DEVELOPMENT PROGRAMS FOR NEW OR IMPROVED SAFEGUARDS EQUIPMENT AND TECHNIQUES; THE EXTENT TO WHICH THE STATE DEPARTMENT'S PROGRAMS ARE COORDINATED WITH PROGRAMS OF OTHER DEPARTMENTS AND AGENCIES, AND OTHER NATIONS; PROBLEMS BEING ENCOUNTERED IN GETTING ADVANCED SAFEGUARDS EQUIPMENT AND TECHNIQUES INTO ROUTINE USE BY THE IAEA; AND THE STATE DEPARTMENT'S LONG-RANGE PLANS FOR IMPROVING IAEA SAFEGUARDS RELATED EQUIPMENT AND TECHNIQUES.

AS PRESIDENT REAGAN EMPHASIZED IN HIS JULY 1981 STATEMENT, IAEA SAFEGUARDS ARE AN IMPORTANT ELEMENT OF U.S. NUCLEAR NON-PROLIFERATION POLICY. THE UNITED STATES IS COMMITTED TO "STRONGLY SUPPORT AND CONTINUE TO WORK WITH OTHER NATIONS TO STRENGTHEN THE IAEA TO PROVIDE FOR AN IMPROVED INTERNATIONAL SAFEGUARDS REGIME". WE ARE LIVING UP TO THAT COMMITMENT.

BEFORE ADDRESSING EACH OF THESE TOPICS, I THINK IT WOULD BE USEFUL TO DESCRIBE CURRENT STATE DEPARTMENT EFFORTS TO IMPROVE THE TECHNICAL ASPECTS OF IAEA SAFEGUARDS, AND COMMENT ON THE POLICY FRAMEWORK WITHIN WHICH THOSE EFFORTS ARE BEING PURSUED.

IAEA SAFEGUARDS ARE ACCEPTED VOLUNTARILY BY COUNTRIES AS A TECHNICAL MEANS OF DEMONSTRATING THEIR POLITICAL COMMITMENT TO USE CIVIL NUCLEAR MATERIALS AND FACILITIES ONLY FOR THEIR STATED PEACEFUL PURPOSES. IN ORDER TO GIVE SUBSTANCE TO THAT COMMITMENT, SAFEGUARDS MUST BE TECHNICALLY CAPABLE OF MEETING THEIR OBJECTIVE, WHICH IS TO DETECT THE DIVERSION OF MATERIALS OR USE OF FACILITIES FOR OTHER THAN FOR THEIR STATED PEACEFUL PURPOSES, AND TO DETER SUCH DIVERSION BY THE RISK OF EARLY DETECTION.

IN FACILITIES CURRENTLY UNDER SAFEGUARDS, THE IAEA HAS THE TECHNICAL CAPABILITY, E.G. THE TECHNIQUES AND INSTRUMENTS, TO APPLY EFFECTIVE SAFEGUARDS. HOWEVER, IN SOME CASES THIS MAY REQUIRE MORE MANPOWER AND EQUIPMENT

THAN IS CURRENTLY AVAILABLE. IT IS, HOWEVER, IMPORTANT TO NOTE THAT NOT ONLY MUST THE INSTRUMENTS, HARDWARE AND SOFTWARE, BE AVAILABLE TO THE IAEA, BUT ALSO THAT THE LEGAL MECHANISMS AND SUBSIDIARY ARRANGEMENTS FOR USING THOSE INSTRUMENTS MUST ALSO BE IN PLACE IF SAFEGUARDS ARE TO BE EFFECTIVE. FOR EXAMPLE, AT SOME ON-LINE FUELED POWER REACTORS IN STATES WITH NEWER FUEL CYCLE FACILITIES NOT UNDER SAFEGUARDS, SOME ARGUE THAT CIRCUMSTANCES MAY REQUIRE THE AMENDMENT OR AT THE LEAST REINTERPRETATION OF PREVIOUS FACILITY ATTACHMENTS. THE IAEA DIRECTOR GENERAL NOTED THIS BY INFORMING THE BOARD OF GOVERNORS IN SEPTEMBER 1981 THAT THE AGENCY CAN NO LONGER GIVE THE REQUISITE ASSURANCES THAT A DIVERSION HAS NOT OCCURED IN CERTAIN SPECIAL CASES. THESE ISSUES ARE BEING NEGOTIATED BETWEEN THE IAEA AND THE STATES CONCERNED.

IN ADDITION TO HAVING THE NECESSARY EQUIPMENT AND DEVELOPING REQUIRED TECHNICAL PROCEDURES, THE IAEA MUST ENSURE THAT THE PRESCRIBED PROCEDURES ARE CARRIED OUT EFFECTIVELY BY THE INSPECTORS IN THE FIELD. INSPECTORS MUST BE TRAINED AND THEIR SKILLS CONTINOUSLY UPDATED AND

IMPROVED. TIMELY ANALYSIS AND REPORTING OF INSPECTION RESULTS MUST BE IMPROVED IN ORDER TO MORE EFFECTIVELY MONITOR INSPECTOR ACTIONS. SOFTWARE MUST BE DEVELOPED AND PUT INTO ROUTINE USE, REPORTING PROCEDURES MUST BE STANDARDIZED, AND A MANAGEMENT SYSTEM MUST BE IN PLACE THAT FACILITATES THE FLOW OF INFORMATION TO THE DEPUTY DIRECTOR GENERAL FOR SAFEGUARDS AND KEY MEMBERS OF HIS STAFF WITH AUTHORITY TO SOLVE PROBLEMS THAT MAY ARISE. IN EACH OF THESE AREAS MANAGEMENT TOOLS ARE BEING DEVELOPED AND IMPLEMENTED, AND REMEDIES SOUGHT WHERE PROBLEMS EXIST.

THE U.S. PROGRAM OF TECHNICAL ASSISTANCE TO IAEA SAFEGUARDS (POTAS), FUNDED THROUGH THE DEPARTMENT OF STATE, ADDRESSES ALL OF THESE AREAS. SINCE ITS INCEPTION IN 1976, 213 INDIVIDUAL PROJECTS HAVE BEEN COMPLETED AND OVER 50 ARE CURRENTLY UNDERWAY. TO DATE, THE U.S. HAS COMMITTED OVER $27 MILLION TO THIS EFFORT. APPROXIMATELY 40 PROFESSIONALS IN THE U.S. AND 17 EXPERTS, PROVIDED COST FREE TO THE IAEA, ARE CURRENTLY INVOLVED IN POTAS. FY 82 EXPENDITURES ARE ABOUT $4 MILLION.

TO ADEQUATELY DISCUSS ALL OF THE INSTRUMENTS AND TECHNIQUES THAT HAVE BEEN DEVELOPED THROUGH POTAS TO DATE WOULD TAKE MUCH LONGER THAN WE HAVE AVAILABLE HAVE TODAY.

I SHALL TRY TO OUTLINE THE TYPES OF WORK BEING CONDUCTED AND THEIR SCOPE. I WOULD BE PLEASED TO ELABORATE DURING THE QUESTION PERIOD.

- IN THE AREA OF NONDESTRUCTIVE ASSAY EQUIPMENT AND CONTAINMENT AND SURVEILLANCE DEVICES SIGNIFICANT PROGRESS HAS BEEN MADE BY THE IAEA IN IMPROVING ITS CAPABILITIES IN THE LAST FEW YEARS AND DURING THIS CURRENT FISCAL YEAR IN PARTICULAR. THROUGH POTAS, AN ENTIRE FAMILY OF NEUTRON COINCIDENCE COUNTING INSTRUMENTS HAS BEEN DEVELOPED AND IS BEING BROUGHT INTO ROUTINE USE BY THE IAEA. THESE INSTRUMENTS INCLUDE: THE HIGH LEVEL NEUTRON COINCIDENCE COUNTER FOR USE WITH PLUTONIUM AND MIXED OXIDE PINS AND EXPERIMENTAL FUEL ASSEMBLIES; THE ACTIVE WELL COINCIDENCE COUNTER FOR USE WITH HIGH ENRICHED URANIUM METAL; AND THE ACTIVE NEUTRON COINCIDENCE COLLAR FOR USE WITH LOW ENRICHED URANIUM POWER REACTOR FUEL ASSEMBLIES. A PASSIVE NEUTRON COINCIDENCE COLLAR FOR FAST BREEDER REACTOR FUEL ASSEMBLIES IS UNDER DEVELOPMENT. THIS FAMILY OF INSTRUMENTS WAS DEVELOPED AT THE LOS ALAMOS NATIONAL LABORATORY. ALL BUT THE LAST OF THESE INSTRUMENTS ARE NOW IN ROUTINE USE BY THE IAEA. THESE INSTRUMENTS GIVE THE IAEA THE ABILITY TO INDEPENDENTLY VERIFY DECLARED MATERIAL CONTENT AND QUANTITY. THIS IS ESSENTIAL IF THE IAEA IS TO ACHIEVE ITS OBJECTIVES.

STILL OTHER INSTRUMENTS IN THIS FAMILY ARE UNDER DEVELOPMENT UNDER POTAS. THESE INSTRUMENTS WILL BE USED WITH FAST BREEDER REACTOR FUEL ASSEMBLIES, BULK URANIUM SUCH AS UO2 RODS, HIGHLY ENRICHED URANIUM METAL AND SCRAP, AND BULK MOX STORAGE.

ANOTHER SURVEILLENCE/NON DESTRUCTIVE ASSAY INSTRUMENT DEVELOPED THROUGH POTAS, AND VERY MUCH IN DEMAND BY IAEA INSPECTORS, IS THE JAVELIN CERENKOV NIGHT VIEWING DEVICE. THIS DEVICE ALLOWS THE INSPECTOR TO SEE THE CHARACTERISTIC BLUE CERENKOV GLOW FROM SPENT FUEL EVEN WHEN THAT GLOW HAS BECOME FAINT BECAUSE THE SPENT FUEL HAS BEEN IN THE STORAGE POND FOR SEVERAL YEARS. THIS BLUE GLOW IS PRODUCED BY ELECTRONS, THAT ARE USUALLY GIVEN OFF DURING RADIOACTIVE DECAY, AS THEY PASS THROUGH WATER. IT IS NAMED FOR THE SCIENTIST WHO FIRST DESCRIBED THE PHENOMENON. GENUINE SPENT NUCLEAR REACTOR FUEL EMITS SUCH ELECTRONS. UNIRRADIATED, FRESH, FUEL DOES NOT. THIS INSTRUMENT PERMITS THE IAEA INSPECTOR TO CONFIRM THAT THE INSPECTED FUEL ASSEMBLIES CONTAIN SPENT REACTOR FUEL, THEREBY COVERING ONE OF THE EASIEST DIVERSION PATHS AT POWER REACTORS, THAT OF SUBSTITUTING DUMMY FUEL.

INTERNATIONAL COLLABORATION WITH OUR CLOSE ALLIES HAS ALSO BEEN PART OF OUR EFFORTS TO DEVELOP NEW INSTRUMENTS AND TECHNIQUES. FOR EXAMPLE, THE K-EDGE DENSITOMETER

WAS DEVELOPED UNDER POTAS BY LOS ALAMOS NATIONAL LABORATORY IN COLLABORATION WITH JAPAN DURING THE TOKAI ADVANCED SAFEGUARDS TECHNOLOGY EXERCISE (TASTEX). THIS IS A VERY IMPORTANT NONDESTRUCTIVE ASSAY INSTRUMENT, WHICH IS BEING BROUGHT INTO ROUTINE USE AT THE TOKAI REPROCESSING PLANT IN JAPAN BY THE IAEA THIS MONTH (AUGUST). THIS DEVICE IS USED TO DETERMINE PLUTONIUM CONCENTRATION IN LIQUIDS GIVING THE IAEA THE ABILITY TO MONITOR PLUTONIUM PROCESS FLOWS IN REPROCESSING PLANTS.

UNDER POTAS, THE U.S. HAS DEVELOPED AND/OR IMPROVED SEVERAL OPTICAL SURVEILLENCE SYSTEMS, INCLUDING BOTH FILM AND TV CAMERAS. A VERY ADVANCED SYSTEM THAT IS CURRENTLY UNDER TEST AND EVALUATION BY THE IAEA IS THE SURVEILLENCE TELEVISION AND RECORDING SYSTEM (STAR) DEVELOPED BY THE SANDIA LABORATORY. THIS SYSTEM, HAS SUCH FEATURES AS 16 POINT MOTION DETECTION, 2 REDUNDANT VIDEO RECORDERS, MICROPROCESSOR CONTROLS, AND TWO VIDEO CAMERAS ALL CONTAINED IN A TAMPER RESISTANT HOUSING. FOR SPECIAL CASES, A "SLAVE" RECORDER IS PROVIDED TO PERMIT A SECOND AUTHORITY TO REMOVE A VIDEO CASSETTE FOR REVIEW BY IAEA AND HOST COUNTRY OFFICIALS DURING AN INTERIM PERIOD. THIS IS USEFUL IN EURATOM COUNTRIES WHERE TWO INSPECTORATES JOIN IN VARIOUS VERIFICATION ACTIVITIES.

ANOTHER INSTRUMENT DEVELOPED THROUGH POTAS FOR TASTEX AND GOING INTO ROUTINE USE AT THE TOKAI MURA REPROCESSING PLANT IN JAPAN IS THE AUTOMATED ELECTROMANOMETER FOR THE MEASUREMENT OF LEVELS OF SOLUTIONS IN ACCOUNTABILITY VESSELS. THIS INSTRUMENT, DEVELOPED AT THE BROOKHAVEN NATIONAL LABORATORY, REDUCES THE BURDEN TO THE THE INSPECTOR IN MONITORING PLUTONIUM STORAGE TANKS AT REPROCESSING PLANTS, SINCE IT PROVIDES A CONTINUOUS, AUTOMATIC MEASUREMENT THAT IS READ ON LINE BY A COMPUTER. IT ALSO IMPROVES THE ACCURACY OF MEASUREMENTS, AND SIGNIFICANTLY CONTRIBUTES TO THE IAEA'S ABILITY TO CLOSE THE MATERIAL BALANCE.

ALL OF THESE EFFORTS HAVE HAD A SIGNIFICANT POSITIVE IMPACT ON IAEA SAFEGUARDS; HOWEVER, GIVEN THE INCREASING NUMBER OF NEW AND LARGER FACILITIES COMING UNDER SAFEGUARDS, THE IAEA'S NEED FOR TECHNICAL ASSISTANCE WILL CONTINUE.

THE STATE DEPARTMENT'S EFFORTS IN THIS AREA ARE CLOSELY COORDINATED WITH OTHER INTERESTED US AGENCIES. POLICY GUIDANCE AND COORDINATION WITH OVERALL U.S. NON-PROLIFERATION EFFORTS ARE PROVIDED BY THE INTERAGENCY STEERING GROUP, COMPRISED OF DOE, NRC, ACDA, NSC STAFF AND CHAIRED BY STATE. POTAS ENJOYS A SIGNIFICANT DEGREE OF COORDINATION AMONG WASHINGTON AGENCIES. POTAS IS DIRECTED BY A TECHNICAL SUPPORT COORDINATING COMMITTEE CHAIRED BY STATE AND INCLUDING REPRESENTATIVES

OF DOE, ACDA, AND THE NRC. THIS COMMITTEE MEETS APRROXIMATELY ONCE A MONTH TO REVIEW THE PROGRESS OF THE PROGRAM AND TO RESOLVE PROBLEMS AS THEY ARISE.

THE DETAILED IMPLEMENTATION OF THE PROGRAM HAS BEEN DELEGATED BY STATE TO DOE. DOE HAS, IN TURN, SET UP THE INTERNATIONAL SAFEGUARDS PROJECT OFFICE (ISPO) AT BROOKHAVEN NATIONAL LABORATORY FOR THE OVERALL TECHNICAL IMPLEMENTATION OF THE PROGRAM. WE HAVE FOUND THIS TO BE A VERY EFFECTIVE AND EFFICIENT SYSTEM. MUCH OF THE ACTUAL DEVELOPMENT WORK IS PERFORMED BY U.S. NATIONAL LABORATORIES, WHICH WERE ESTABLISHED TO PROVIDE TECHNICAL SUPPORT FOR PRIORITY NATIONAL PROGRAMS INVOLVING NUCLEAR TECHNOLOGY. PARTICIPATING LABORATORIES INCLUDE LOS ALAMOS, SANDIA, OAK RIDGE, IDAHO NATIONAL ENGINEERING LAB, ARGONNE, BROOKHAVEN, PACIFIC NORTHWEST LAB, LIVERMORE AND OTHERS.

IN MY OPENING REMARKS I DISCUSSED THE SCOPE AND COSTS OF THE STATE DEPARTMENT'S EFFORTS TO IMPROVE THE APPLICATION OF IAEA SAFEGUARDS. OUR PROGRAM WAS THE FIRST OF ITS KIND AND HAS SERVED AS THE MODEL FOR NEWER PROGRAMS SUCH AS THOSE OF JAPAN, THE FRG, THE U.K,, CANADA, AUSTRALIA AND THE SOVIET UNION. EURATOM NOW ALSO HAS A JOINT PROGRAM WITH THE IAEA.

THE POTAS PROGRAM IS BY FAR THE LARGEST OF THESE EFFORTS. MOST OF THE ADVANCED NONDESTRUCTIVE ASSAY EQUIPMENT NOW AVAILABLE TO THE IAEA WAS DEVELOPED THROUGH POTAS.

WE ARE WORKING WITH JAPAN, AUSTRALIA, AND WITH THE U.K., THE FRG AND THE NETHERLANDS (THE URENCO GROUP) ON THE HEXAPARTITE SAFEGUARDS PROJECT, WHICH IS AIMED AT DEVELOPING SAFEGUARDS APPROACHES TO GAS CENTRIFUGE ENRICHMENT PLANTS, INCLUDING SAFEGUARDS RESEARCH, DEVELOPMENT AND DEMONSTRATION. THIS PROJECT IS NEARING COMPLETION. WE EXPECT TO MAKE RECOMMENDATIONS TO THE IAEA BY THE END OF THE YEAR.

WHILE INDIVIDUALS FROM THE US HAVE GOTTEN TO KNOW THEIR COUNTERPARTS IN OTHER GOVERNMENTS AND HAVE ESTABLISHED GOOD WORKING RELATIONSHIPS, THE NUMBER OF PROGRAMS HAS GROWN TOO LARGE FOR SUCH AD HOC COORDINATION. THUS, FOLLOWING AN IAEA SAFEGUARDS SYMPOSIUM IN NOVEMBER, THE COORDINATORS OF THE VARIOUS NATIONAL PROGRAMS WILL MEET IN VIENNA FOR A WEEK TO EXCHANGE VIEWS AND POSSIBLY TO DEVELOP JOINT PROJECTS.

MOST OF THE EQUIPMENT AND TECHNIQUES DEVELOPED THROUGH POTAS AND OTHER SUPPORT PROGRAMS ARE "STATE OF THE ART", THAT IS THEY UTILIZE NEW CONCEPTS DEVELOPED IN SOME CASES SOLELY FOR USE IN INTERNATIONAL SAFEGUARDS. IAEA STAFF CANNOT BE EXPECTED TO EMBRACE THEM IMMEDIATELY AND PUT THEM INTO ROUTINE USE. TIME AND EFFORT ARE REQUIRED TO TRAIN THE IAEA STAFF, TO TEST AND EVALUATE THE SYSTEMS, TO MAKE THE CHANGES THAT ARE NECESSARY TO ENSURE EASE OF OPERATION EVEN UNDER DIFFICULT FIELD CONDITIONS, AND TO INCORPORATE THE EQUIPMENT AND TECHNIQUES INTO STANDARD OPERATING PROCEDURES.

IN RECOGNITION OF THE PROBLEMS FACED BY THE IAEA IN GETTING INSTRUMENTS AND TECHNIQUES INTO ROUTINE USE BY THE INSPECTORATE, EMPHASIS IN POTAS HAS BEEN SHIFTED FROM DEVELOPMENT OF INSTRUMENTS AND TECHNIQUES TO PROVIDING ASSISTANCE TO THE IAEA IN BRINGING DEVELOPED TECHNOLOGY INTO ROUTINE USE THORUGHOUT THE IAEA'S SAFEGUARDS PROGRAM. WE ARE WORKING CLOSELY WITH THE IAEA AND THE DEVELOPERS OF EQUIPMENT, MAINLY THE NATIONAL LABS, TO COMPLETE THE DEMONSTRATION AND IMPLEMENTATION OF THE EQUIPMENT AND PROCEDURES THAT HAVE ALREADY BEEN DEVELOPED AND TO BRING THESE INTO ROUTINE USE BY THE INSPECTORATE. WE ARE ALSO WORKING WITH THE IAEA TO REDUCE THE TIME REQUIRED TO DEVELOP AND IMPLEMENT INSTRUMENTS AND TECHNIQUES THAT MAY BE REQUESTED BY THE IAEA IN THE FUTURE.

IN THIS REGARD WE HAVE BEGUN TO ACQUIRE FIRST-HAND

EXPERIENCE OF THE PROBLEMS FACED BY IAEA INSPECTORS IN THE FIELD THROUGH IMPLEMENTATION OF THE US/IAEA SAFEGUARDS AGREEMENT. UNDER THIS AGREEMENT THE IAEA IS CONDUCTING INSPECTIONS AT TWO POWER REACTORS, TROJAN AND RANCHO SECO, AND THE EXXON LOW ENRICHED URANIUM FUEL FABRICATION PLANT IN RICHLAND, WASHINGTON. THIS EXPERIENCE SHOULD ENABLE US WORK MORE EFFECTIVELY WITH THE INSPECTORATE TO SOLVE PROBLEMS RELATED TO THE UTILIZATION OF NEW EQUIPMENT.

IN THE LONG TERM, OUR INCREASING ATTENTION WILL BE HAVE TO BE FOCUSED ON ENSURING THAT THE IAEA HAS THE TOOLS AT ITS DISPOSAL TO SAFEGUARD THE LARGE BULK HANDLING FACILITIES THAT WILL BE COMING ON LINE. THIS INCLUDES: REPROCESSING PLANTS, ENRICHMENT PLANTS, MIXED OXIDE FUEL FABRICATION PLANTS, AND PLUTONIUM AND MOX STORAGE FACILITIES. SAFEGUARDING THESE FACILITIES, ESPECIALLY IF LARGE, WILL REQUIRE INCORPORATING INTO THE PLANT DESIGN ALREADY IDENTIFIED SAFEGUARDS MEASURES SUCH AS NEAR-REAL TIME ACCOUNTANCY

IF SAFEGUARDS ARE TO BE BOTH EFFECTIVE AND UTILIZE THE RESOURCES AVAILABLE TO THE IAEA IN THE MOST EFFICIENT WAY.

WORK IS ALREADY IN PROGRESS IN ALL OF THESE AREAS, THROUGH POTAS AND OTHER EFFORTS, SUCH AS THOSE OF DOE AND ACDA, SUPPORTED BY THE USG. WE EXPECT THESE EFFORTS TO EXPAND IN THE FUTURE. FOR EXAMPLE, WE EXPECT TO WORK CLOSELY WITH JAPAN IN DEVELOPING TECHNIQUES FOR SAFEGUARDING LARGE REPROCESSING PLANTS. WE HAVE BEEN, AND WILL CONTINUE TO, WORK WITH THE IAEA, ACDA AND OTHERS IN SUPPORT OF THE WORK ON REMOTE CONTINUAL VERIFICATION (RECOVER). THIS IS THE SYSTEM THAT REMOTELY MONITORS CERTAIN SPECIALLY DESIGNED SAFEGUARDS INSTRUMENTS SUCH AS CAMERAS AND SEALS TO INSURE THEIR PROPER OPERATION EVEN WHEN IAEA INSPECTORS ARE NOT PRESENT. IT COULD, THEREFORE, BE USEFUL IN LENDING ADDED ASSURANCE TO SAFEGUARDS PROCEDURES WHILE POTENTIALLY REDUCING IAEA MANPOWER REQUIREMENTS. WE ALSO EXPECT TO HELP SUPPORT THE TRANSEAVER DEVELOPMENT AND DEMONSTRATION EFFORT SPEARHEADED BY ACDA. TRANSEAVER USES THE RECOVER CONCEPT AND HARDWARE TO ALLOW CONTINUAL SURVEILLENCE OF SPECIALLY DESIGNED IAEA SAFEGUARDS INSTRUMENTS DURING THE SHIPMENT OF MATERIALS BY SEA. THIS CONCEPT IS NOW GOING INTO THE TEST AND EVALUATION PHASE.

ATTENTION WILL CONTINUE TO BE FOCUSED ON HELPING THE IAEA SOLVE PROBLEMS AS THEY ARISE IN PARTICULAR FACILITIES. THIS COULD INCLUDE SYSTEM STUDIES, HARDWARE DEVELOPMENT OR/AND HARDWARE PROCUREMENT.

IN SUM THE STATE DEPARMTENT'S EFFORTS IN SUPPORT OF IAEA SAFEGUARDS ARE MULTIFACETED AND COVER ALL AREAS OF CONCERN. WE ARE COMMITTED TO CONTINUING TO IMPROVE SAFEGUARDS SO THAT NEW TECHNOLOGIES CAN BE BROUGHT TO BEAR AND THE SAFEGUARDS SYSTEM ADAPTED TO DEALING WITH EXPANDED PEACEFUL USES OF NUCLEAR ENERGY. THIS WILL INLCUDE THE INAUGURATION OF SEVERAL SENSITIVE FACILITIES SUCH AS REPROCESSING PLANTS LARGER THAN THOSE CURRENTLY IN EXISTENCE AND MIXED OXIDE FUEL FABRICATION FACILITIES. SUCH FACILITIES ARE ADMITTEDLY MORE DIFFICULT TO SAFEGUARD ADEQUATELY THAN THOSE CURRENTLY ON LINE.

IN THIS EFFORT, AND THOSE I HAVE DESCRIBED PREVIOUSLY, WE SHALL CONTINUE TO WORK CLOSELY WITH THE IAEA AND WITH KEY IAEA MEMBER COUNTRIES.

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TESTIMONY OF NRC
BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

AUGUST 3, 1982

Madam Chairman, members of the Subcommittee, we are here today at your invitation to discuss NRC's safeguards programs. Your letter of invitation indicated particular interest in devices and techniques used in nuclear safeguards applications. I think it is important to note, therefore, that NRC's research and technical assistance programs are not generally intended to develop safeguards-related hardware. We look to the Executive Branch and the private licensed commercial nuclear industry for such development.

The main purpose of NRC's research and technical assistance programs is to develop technical information which will aid the staff and Commission in resolving regulatory issues and provide a sound basis for NRC's regulatory requirements. In fact, it is the Commission's policy to allow domestic licensees considerable freedom in designing their own safeguards systems as long as they satisfy NRC's regulatory performance requirements.

NRC SAFEGUARDS PROGRAMS

Under the Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974 the NRC requires safeguards in licensed domestic activities to assure protection of the public health and safety and the common defense and security. To accomplish this, NRC requires that measures be taken to deter, prevent and respond to the unauthorized possession or use of special nuclear material, and to protect against sabotage of nuclear facilities. In general, safeguards for fuel cycle facilities emphasize protection against theft or diversion of special nuclear material (SNM), while those for power reactors stress protection against radiological sabotage.

In the international safeguards area, NRC cooperates with Department of State, ACDA and DOE in support activities coordinated through the Action Plan Working Group and the Technical Support Coordinating Committee to improve international safeguards. Since 1978, NRC's role in the Group has been to carry out numerous technical assistance and direct support activities, including the following:

- Sponsored a technical objectives study on goals of IAEA safeguards and associated resource implications.
- Sponsored related studies to identify design features which improve IAEA safeguards at light water reactors, mixed-oxide fuel fabrication facilities, and reprocessing plants.
- Provided NRC staff to assist the IAEA in analyzing inspection results and developing quality assurance programs.

- Assisted the IAEA in an information reporting exercise to develop a prototype facility reporting system.
- Participated in IAEA training courses for foreign officials and technical experts.
- Participated on the steering committee for the now completed TASTEX program to field test advanced safeguards instrumentation and approaches at the Japanese reprocessing plant at Tokai.

SPECIFIC ISSUES

The Subcommittee asked us to address several issues including adequacy of equipment and techniques, R&D programs, interagency coordination, and long-range plans for improving safeguards.

Adequacy of the present non-destructive assay equipment, and containment and and surveillance devices and techniques being used domestically by the International Atomic Energy Agency

Safeguards areas which continue to require improvement involve materials measurement and accountability, protection against "insider" sabotage at reactors and IAEA safeguards.

Measurement technology has still not reached a level sufficient to achieve a "closed material balance" based on measurements for certain classes of materials in bulk processing facilities. Recognizing limitations of material measurements, especially non-destructive assay (NDA), proposed domestic regulatory reforms are being developed for high-enriched uranium and plutonium that will emphasize more timely detection and loss resolution, consistent with research and technical assistance studies of process monitoring concepts.

With regard to power reactors, an issue of continuing concern to NRC is protection against sabotage by an "insider". Related research and technical assistance have focused upon the definition and identification of vital areas and components at power reactors.

The IAEA has identified a number of issues which need resolution to provide improvements in the IAEA safeguards program. Among the main issues identified by the IAEA are the limited manpower of the inspectorate, restrictions placed by some States on the acceptance of IAEA inspectors, and availability of suitable instruments. With regard to the instruments, non-destructive assay equipment has not been fully developed and field tested for some forms and types of materials and currently-utilized surveillance devices have limited reliability.

Scope, Effectiveness, and cost of the NRC's R&D programs to develop new or improved safeguards equipment and techniques

As I stated previously, the main purpose of NRC's research and technical assistance programs is to develop technical information which will provide a sound basis for regulatory requirements.

Current safeguards research and technical assistance is oriented towards NRC's regulations and guides. For example, domestic licensees are now completing NRC-required upgrading of safeguards in power reactors and fuel facilities. Associated with those NRC requirements published in Title 10 Part 73 of the Code of Federal Regulations were research and technical assistance contractual efforts. Products of those contractual efforts provided licensee guidance on closed-circuit television systems, intrusion alarm systems, site security personnel training, alarm station design, work rules to enhance safeguards, emergency power supplies for physical security systems, hardening of SNM storage facilities, and vehicle access and search.

Safeguards for spent fuel shipments provide another interesting example of regulatory research. Because of large uncertainties in predicted consequences resulting from explosive sabotage of a spent fuel shipment, both NRC and DOE sponsored research programs to reduce the margins of uncertainties. The NRC program, initiated in 1979, consisted of experiments that used scaled-down explosives against simulated shipping casks containing irradiated material. The DOE program used a full-scale explosive charge against a full-scale cask containing unirradiated fuel. The programs were completed in 1982 and final reports are expected by the end of the year. Results indicate that consequences would be considerably less than predicted earlier. These results are now being reviewed for regulatory implications.

NRC's budget for fiscal year 1982 included 3.5 million dollars for safeguards technical assistance and 3.1 million dollars for research.

Extent to which the NRC's programs are coordinated with programs in other agencies and departments, as well as with other nations through existing technological agreements

NRC has a Safeguards Technical Assistance and Research Coordinating (STAR) Group, with members from each cognizant office to provide inter-office coordination for the safeguards research program within NRC. The STAR Group is responsive to NRC's national program manager for domestic safeguards and protects against duplications and overlap and assures program relevance of contracted projects.

NRC's projects are also coordinated with other agencies of government. For example, every year the NRC staff formally transmits descriptions of proposed projects to DOE and DOD for coordination. We receive formal written assurance from these agencies that we are not duplicating their projects.

The NRC is not involved in any safeguards technological agreements with other nations. However, as I mentioned earlier, the NRC does participate in international safeguards programs through the Action Plan Working Group and the

Technical Support Coordinating Committee. The Technical Support Coordinating Committee was organized in 1976 to manage the U.S. Program for Technical Assistance to IAEA Safeguards (POTAS). This program, funded by Department of State under the Foreign Assistance Act, provides direct technical support to the IAEA. The largest POTAS effort continues to address the issue of equipment for inspector verification of nuclear materials. More than 20 kinds of equipment are now in the hands of the IAEA for test, demonstration, or operational use. This year a major part of the POTAS effort involves field testing and placing into routine use equipment developed and supplied by the U.S. to the IAEA; preparation of training and maintenance manuals; provision of "hands-on training" to IAEA employees and other types of technical backup needed to qualify new instrumentation and equipment for routine inspection use.

Problems being encountered in getting advanced safeguards equipment and techniques into routine use domestically and by the International Atomic Energy Agency

The NRC is not aware of any particular problems being encountered in getting advanced safeguards equipment and techniques into routine use domestically. In support of the IAEA, implementation plans have been formulated and are being exercised to facilitate the routine use of advanced safeguards equipment and techniques in the IAEA inspection program.

NRC's long range plans for improving domestic and international safeguards equipment and techniques

Future NRC research will emphasize new safeguards concepts, human factors, support to regional operations, and examination of foreign safeguards technology.

Future technical assistance to support material control and accountability will include work to improve statistical treatment of materials accounting data and to develop an Automated Material Accounting Statistics System (AMASS) permitting independent evaluation of material balance and process data.

Planned NRC technical assistance projects related to IAEA include a study of design features to facilitate IAEA safeguards and provision of assistance to strengthen IAEA safeguards in facilities having most sensitive proliferation concerns.

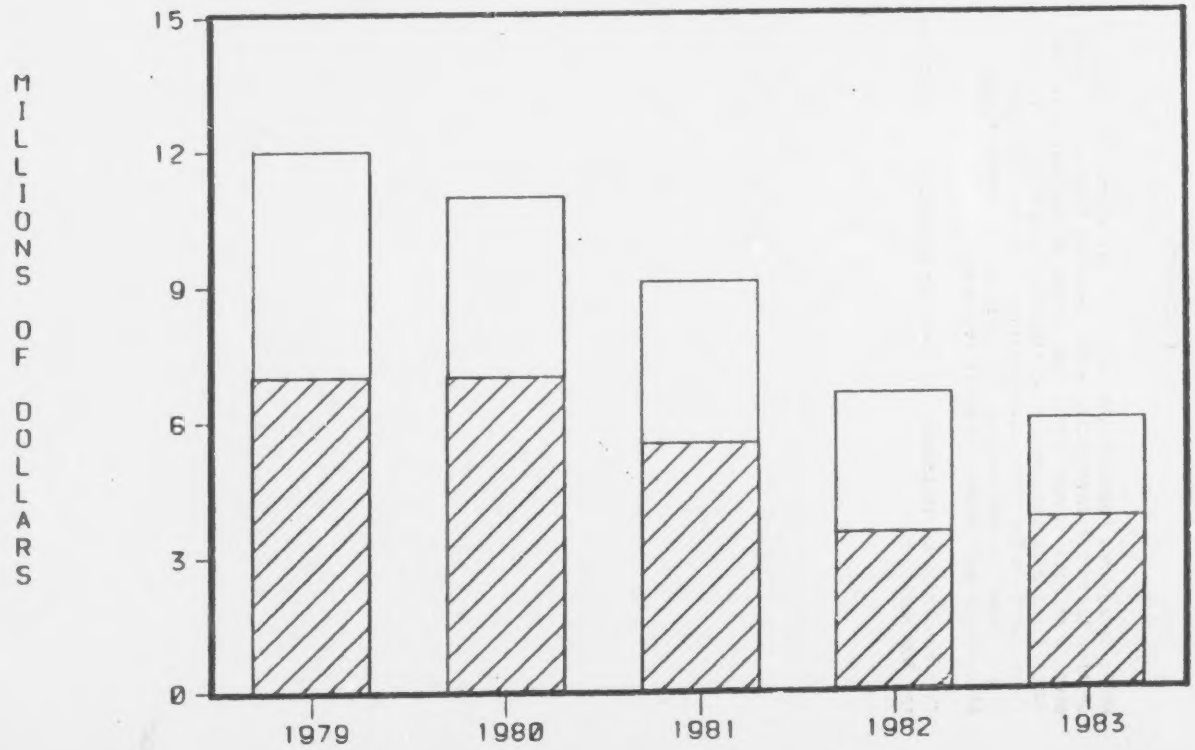
The results of research to assist in developing design criteria for future nuclear power plants have recently been published. Three follow-on reports which discuss damage control measures and potential sabotage protection design changes for existing reactors are currently being published. Additional research has been initiated in FY 1982 to better model system interactions and common mode failures which could result from acts of sabotage. The results of this research project, which will extend through FY 1985, will be used in assessing the effectiveness of current NRC regulations to protect against sabotage by an insider.

CONCLUSION

NRC's safeguards research and technical assistance programs are designed to develop technical information which bears on regulatory issues rather than to develop safeguards equipment. Our research programs have been more sharply focused and have been declining steadily in cost over the last five years, as illustrated in the chart accompanying my written statement. However, NRC safeguards research programs, as proposed in the current budget, are considered adequate to meet presently perceived needs.

This concludes my statement. I would be pleased to respond to questions from the Subcommittee.

NRC SAFEGUARDS RESEARCH AND TECHNICAL ASSISTANCE



U.S. CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT

Nuclear Proliferation and Safeguards

UPDATE

The administration and Congress are currently reassessing U.S. strategy for preventing the spread of nuclear weapons. To help policymakers put proliferation in perspective with other national objectives, the Office of Technology Assessment is reissuing the summary of its report, **Nuclear Proliferation and Safeguards.** This OTA study was completed when the Carter administration and the 95th Congress were similarly formulating a nonproliferation program. While clearly both the domestic and international climates have changed in the intervening 4 years, most of the technological, economic, and political factors influencing the ability and desire to acquire nuclear weapons have not. The OTA assessment was a comprehensive study of those factors and their complex interactions.

Several recent events have stimulated interest in proliferation issues. First, the Israeli destruction of an Iraqi nuclear research reactor demonstrated that Israel would not rely on existing international mechanisms to prevent suspected diversion of nuclear materials from nonmilitary nuclear facilities. This incident may have created a climate more receptive to stronger, more credible control measures. Second, the new French Government is expected to tighten their nuclear export policies. This action would allow a more consolidated front in insisting on more rigorous safeguards. Finally, declining growth rates of nuclear power throughout the world have reduced the pressure to build enrichment and reprocessing plants which are particularly vulnerable to diversion.

While these events increase the likelihood that the United States will find a more receptive climate abroad for nonproliferation initiatives, other events have occurred in this country that could lead to a moderation of U.S. nonproliferation policy. They are primarily a result of conflicts with other national goals and values which have changed over time. For example, the United States' hardline policy toward Pakistan, which was based on that country's efforts to develop nuclear weapons, was moderated when the Soviet Union invaded Afghanistan. A second example of such events is the current criticism by the U.S. nuclear industry of the Nuclear Non-Proliferation Act of 1978. The industry claims that the act is unnecessarily restrictive of nuclear exports. Others have also recently reviewed the act for its general effectiveness including a recent study by the General Accounting Office ("The Nuclear Non-Proliferation Act Should Be Selectively Modified," May 21, 1981).

Because of these and other recent domestic and international developments, the time now appears ripe to review this Nation's nonproliferation policy. Few issues are as complex as those which involve reconciling the benefits and dangers of nuclear energy. The OTA report addressed many of them. The following 11 issues, which are of particular current interest, are described in this summary to highlight how the OTA report might be used. The executive summary of the main report follows with more detail.

ISSUES

1. The Linkage of Commercial Power Programs and Nuclear Weapons Capability.—Many nations have built commercial nuclear powerplants with the assistance of the United States and other nuclear exporting countries. The OTA report surveyed the various steps in the commercial fuel cycle, and highlighted points at which special nuclear material is exposed and vulnerable to diversion. Ordinary light water reactors by themselves are not a great threat, though some observers fear that the acquisition of nuclear materials and technologies, albeit for peaceful purposes, takes a nation too far down the path toward nuclear weapons. The most troublesome facilities are isotopic enrichment and spent fuel reprocessing plants and places where large quantities of purified plutonium and highly enriched uranium are stored. OTA noted that foreseeable safeguards measures are not adequate to detect removal from such facilities of enough material to construct several bombs. The breeder reactor requires reprocessing and recycle of plutonium. Hence, widespread use of breeders would complicate proliferation control.

2. The Linkage of Nuclear Research Reactors and Nuclear Weapons Capability.—Most of the nations (e.g., India, Iraq, and Israel) suspected of harboring nuclear weapons ambitions have research reactors that could be used to produce the necessary nuclear material. Those fueled by highly enriched uranium pose the additional risk that fresh fuel could be diverted. Thus, research reactors as well as power reactors have aroused considerable concern. The OTA study noted this potential link between the scientific and military applications. It described the various types of nuclear research reactors and enumerated the existing reactors that are capable of consuming or producing appreciable quantities of weapons-grade nuclear fuel.

3. Other Avenues To Acquire Nuclear Fuels.—Pakistan appears to be on the road to acquiring nuclear weapons material outside the context of its commercial or research programs. Efforts are underway to build an enrichment plant despite international attempts to prevent the diffusion of this technology. In this case, classified information about centrifuge enrichment was reportedly stolen, and critical equipment surreptitiously imported to build a plant based on this technology.

The OTA report described ways by which a nation might independently construct a nuclear facility dedicated to the production of nuclear weapons fuel. Specifically the report estimated the cost in time, money, and manpower for a nation to fabricate clandestinely either a plutonium production reactor, reprocessing plant, or enrichment plant. The reactor and reprocessing plant would be feasible even for a developing country but the enrichment plant requires a considerably higher level of technology.

Clandestine acquisition of centrifuge enrichment technology illustrates another route to nuclear weapons studied by OTA. That route, the purchase or theft of nuclear technology, materials or even bombs, cannot be ignored in safeguarding nuclear materials.

4. Adequacy of International Safeguards To Detect the Diversion of Nuclear Material From Nuclear Research or Power Facilities.—Experts are still debating whether the International Atomic Energy Agency's (IAEA) safeguards applied to Iraq's Tamuz research reactor would have been adequate to detect quickly either the diversion by Iraq of some of its highly enriched uranium fuel or the production of weapons-usable plutonium. The OTA study surveyed the safeguards techniques currently used and those still under development. For a reactor, where the fuel is in discrete bundles, the materials accountancy techniques are reasonably effective. OTA notes, however, that materials accounting techniques alone are neither sufficiently accurate nor timely enough to trace the flow of nuclear materials through large-scale enrichment or reprocessing plants. IAEA has not yet developed nor tested the containment and surveillance techniques to safeguard such facilities adequately. Their effectiveness is further hampered by restrictions placed on IAEA inspectors.

5. Effectiveness of Institutional Barriers to the Spread of Nuclear Weapons.—There are some serious weaknesses in the present international nonproliferation "regime." By bombing the Iraqi reactor, Israel rejected dependence on these controls. The nonproliferation treaty (NPT) does not apply to nonsignatories. Therefore, Pakistan, which has not signed the NPT, is not violating the treaty in building its enrichment plant even though it appears to be part of a weapons program. Further, although Iraq is a party to the NPT, and has done nothing in violation of the treaty, some of its actions seem more consistent with a weapons development program. These examples suggest it is time to evaluate the international nonproliferation measures in place and where they might be strengthened.

The OTA report surveyed the existing international institutions such as IAEA, the NPT, the Suppliers' Conferences, and Euratom. Beside presenting a factual background about these institutions, the report examines the delicacy and difficulty of their role: For example, imposing tight control on nuclear-weapons materials without unduly trespassing on national sovereignty, and restricting access to nuclear weapons without curtailing the availability of nuclear benefits.

6. Nuclear Supplier Role.—Since the early 1970's, the United States has provided a decreasing share of enriched uranium fuel and nuclear equipment to world markets. In recent years, new export criteria have further limited U.S. shipments abroad. The new administration has stated its intent to reverse this trend and regain U.S. leverage as a "reliable supplier."

Whether the United States can reestablish itself as a reliable supplier depends partly on the demand for nuclear fuels and services and partly on the competition from other exporting nations. In its review of the worldwide nuclear industry, OTA described both the decreasing growth in nuclear power and the increasing capacities (especially in enrichment facilities) of other supplier nations.

The OTA report also addressed the complex relationships among nuclear exporting and importing nations. The United States cannot apply very stringent export controls unilaterally without incurring the resentment of importing nations and driving them to other suppliers. In its relations with other suppliers the United States is simultaneously a competitor in the nuclear market and an ally in international security agreements. It has so far been alone in the intensity of its concern about proliferation and faces a challenge to gain the cooperation of other suppliers in more stringent multilaterial controls. The United States must also consider the needs and desires of importing nations in evaluating the consequences of its nonproliferation policies.

7. Interaction Between the U.S. Domestic Nuclear Program and the International Nonproliferation Climate.—The United States is by far the largest user of nuclear power even though it only accounts for about 11 percent of our electricity production. Decisions made here will inevitably influence other nations by setting an example or by affecting the supply of fuel. Domestic decisions can unwittingly affect proliferation risks abroad. For instance, the Carter policy to forego reprocessing strengthened our bargaining position in trying to deny these vulnerable facilities to potential proliferators, but it could also eliminate a source of nuclear fuel. Fuel is plentiful now, but future scarcity could increase the incentives for other nations to build reprocessing plants and other hard-to-safeguard fuel cycle facilities. Worldwide development of breeder reactors would also raise significant proliferation concerns although they could also eliminate uranium resource concerns. The OTA report investigated the need for such facilities in the United States and their impact abroad.

Foreign sales have become increasingly important to U.S. nuclear corporations as domestic business has dropped. U.S. nonproliferation policy has hampered exports—one of the factors stimulating the current reappraisal. Though the OTA report was prepared before the Nuclear Non-Proliferation Act of 1978 was passed, it examined the nuclear industry and its products both in the United States and abroad.

8. Other U.S. Initiatives To Limit Nuclear Proliferation.—The OTA report outlined various policy options—unilateral, bilateral, and multilateral. It assesses both their cost and potential impact. The report suggests the need for bilateral approaches to be tailored to each particular nation. These options are assessed in light of the need to balance nonproliferation with other foreign policy goals.

9. Feasibility of Weapons Production.—Some observers have contended that building a bomb is a relatively simple matter for a nation or even a terrorist group. The OTA study contains an unclassified assessment prepared by experts in the design and construction of nuclear weapons. The study estimates the amount of material and level of effort that might go into a weapons program, and describes the yield and predictability of the device that would result. The task is well within the capability of any nation with a significant scientific infrastructure, but the quality of the weapons would depend strongly on the capability of the people involved.

10. Protection of U.S. and Worldwide Nuclear Facilities Against Theft of Materials by Nonstate Groups.—This question fortunately has not been tested by any real terrorist attempt, but the possibility cannot be ignored. The OTA study describes the current state-of-the-art for domestic physical security, and assesses future research needs.

11. Incentives and Disincentives for a Nation To Acquire a Nuclear Weapon.—Many nations have the technological capability to construct nuclear weapons, but their incentives have so far been outweighed by the disincentives. The nations most strongly suspected of having clandestinely produced weapons or begun the effort are those who are most isolated, diplomatically or militarily, or who feel threatened by a powerful neighbor. The OTA study concentrated on case studies to illustrate how the varied set of incentives and disincentives interact within any particular nation. Understanding these complex motivational factors is critical for an effective nonproliferation policy.

EXECUTIVE SUMMARY

Incentives and Disincentives

As the technological and economic barriers to proliferation have diminished, the decision whether or not to acquire nuclear weapons has become principally political. It will hinge on a complex balance of incentives and disincentives which, though unique for each country, exhibit sufficient similarities to permit generalization.

General **incentives** that might lead a government to select the nuclear weapons option include the following:

1. **Deterrence.**—Several states on every list of potential new nuclear weapons states (Nth countries) have reason to fear direct attack or

Civil Liberties Implication of Safeguards

Whether a safeguards program to protect special nuclear material in a plutonium industry would jeopardize civil liberties has been a growing topic in the plutonium recycle debate. The concern is not only to protect rights of privacy, free expression, and fair procedure for employees of a plutonium recycle industry, but also to ensure that residents of nearby communities, political critics, and society at large are not subjected to unacceptable levels of surveillance in order to prevent diversion attempts, or to even more harsh and intrusive techniques if recovery of diverted material had to be undertaken. Judgments on what safeguards measures would be reasonably required and what their civil liberties implications would be is, in the first instance, a matter of public policy for elected officials and the public, and only later an issue that might produce judgments of constitutionality or interpretive modifications from the courts.

Concern over the civil liberties implications of plutonium recycle first arose when projections of the size of the industry were much higher than they are now. It now appears that only about 20,000 employees will be required to have clearances for work in the fuel cycle. Transportation of pure plutonium could possibly be eliminated by arrangements such as colocation or coprocessing. Both lowered growth and potential technological innovations affect perceptions of civil liberties problems.

It is generally accepted that protecting plutonium facilities from diversion efforts would represent a genuine security need, that there is no way to structure an adequate safeguards program that would not actually or potentially have some civil liberties impact, and that there is no way for society to eliminate all the motivations under which terrorists or deranged persons might try to divert plutonium for their purposes. As a result, safeguards measures of the kind used in other high-security contexts would have to be applied here.

Such safeguards fall into four categories: 1) employee screening, 2) material protection, 3) threat analysis, and 4) recovery measures. In each, there are possible techniques ranging from those raising minimal threats to civil liberties to those that, if used, would raise far more serious questions.

The debates over what safeguards would be needed and how these would affect civil liberties has produced three main positions:

Position 1 maintains that a plutonium economy would require such extensive security safeguards and have such high impact on civil liberties that basic freedoms would be jeopardized. It assumes that Congress and the public would insist on a rigorous, virtually zero-risk program, especially if actual incidents heightened concern. Furthermore, preventive intelligence programs would inevitably be expanded to cover antinuclear groups and protest movements and lead to a rise in surveillance, databanks, and infiltration of dissenters, not just terrorists. Finally, should there be a successful diversion and blackmail threat, sweeping incursions of personal and press freedoms would take place. To avoid creating risks of such dangers, and because it is believed there are alternative ways of conserving and securing energy that do not raise comparable threats to civil liberties, advocates of this position call for a rejection of plutonium recycle in the United States on civil liberties grounds.

Position 2 maintains that safeguards can be adopted that would be both effective for security purposes and acceptable in terms of civil liberties, just as other high-security activities are now safeguarded. Believing that plutonium is a necessary and safe energy source, the notion is rejected that threats from a handful of terrorists or deranged persons should force this Nation to forego plutonium recycle. Because persons working in this industry would do so voluntarily, there would be nothing improper in using techniques such as personnel clearances or on-the-job surveillance. Diversion and bomb threats should be treated with the same professional skills that would be used for other terrorists threats, whether with chemical, biological, or nuclear material or in hostage situations. Preventive intelligence activities would be put under clear legislative guidelines and supervisory checks. Position 2 concludes that plutonium recycle should be allowed to proceed and that continually improved safeguards systems should be developed as the industry grows.

Position 3 would also go ahead with plutonium recycle but only if the philosophy of a safeguards program were that some small risks of diversion would be accepted in order to avoid major risks to civil liberties. They would limit safeguards measures to those meeting specific criteria of effectiveness, limitation, and capacity for control against abuse. A least intrusive measure standard would be followed. This position would require such standards to be developed in public proceedings, written into legislation, monitored by independent review, and regularly audited.

These sets of assumptions and judgments could be significantly affected by alterations in a plutonium system or in safeguards options. Transportation risks might be reduced if the policy of colocating reprocessing and fuel fabrication plants were adopted. Coprecipitation of plutonium and uranium at the reprocessing plant would also eliminate the transport of pure plutonium. Such measures, coupled with the use of hardened facilities, could reduce the pressures to use intrusive preventive intelligence measures.

However, some observers believe that the fundamental civil liberties problems would still remain, especially in a recovery operation.

These three approaches on civil liberties not only rest on sociopolitical judgments about liberty and security but also mirror the main positions on plutonium recycle in terms of safety and economy. Thus, the civil liberties aspect is one portion—though a very important part—of the total judgment about plutonium recycle. If plutonium recycle does go forward, a most important task will be the close and steady monitoring of the safeguards program to keep it consistent with U.S. civil liberties.

Control of Proliferation

Attempts to acquire nuclear weapons by any of the three routes just discussed are subject to four general levels of control effort. The first is detection of the attempt, either by safeguards which watch for diversion from commercial nuclear material flows, or by intelligence activities which can spot dedicated facilities or illegal nuclear transactions. The second level is the response to the detection of such activity in order to force its reversal and deter others from like actions. Sanctions administered by other nations are one method of response. The third level is the restriction of nuclear systems to those that present the lowest risks for proliferation. Supplier agreements can coordinate a ban on sales of enrichment and reprocessing plants and emphasize the development of new systems. The final level is creation of an international climate, through treaties and commitments, wherein nations will not want to proliferate or will find it difficult to do so for political reasons. Each of these levels has produced institutions and arrangements to perform the needed functions. Many of the components would benefit from strengthening, but together they present an effective, though not insurmountable, barrier to proliferation.

The first part of this section will survey the safeguards technology to detect diversion. The second part will discuss the various institutions and arrangements that assist in the levels of proliferation control.

Safeguards

The objective of domestic safeguards in the United States is to detect, deter, prevent, and respond to theft or sabotage by a nonstate adversary. The objective of international safeguards such as those applied by IAEA is to detect diversion of nuclear material by a nation from its own nuclear facilities. In addition, international safeguards should assist the national safeguards system in detecting nonstate diversion.

U.S. DOMESTIC SAFEGUARDS

The three basic elements of the U.S. system are physical protection, material control, and material accountancy. Physical protection elements are those that prevent unauthorized outsiders from entering a facility or seizing control of a transport vehicle, and prevent nuclear material from leaving by an unauthorized route. Examples are armed guards, barriers, and portal monitors. Material control measures consist of procedures for access to and transfer of special nuclear material. They are aimed at preventing any two insiders acting in collusion from removing nuclear material from the facility. Materials accounting for nuclear material is similar to accounting systems for other valuable materials, involving complete records of the movement of material and the taking of periodic physical inventories. The physical protection and material control systems are the primary safeguards measures in the United States.

Safeguards were not given high priority by the public or the Government until recently. Several years ago, safeguards began to attract widespread interest and increased funds were provided, but, a sudden surge of interest and money cannot quickly compensate for years of complacency.

The United States has three major nuclear programs, and three agencies (ERDA, the Nuclear Regulatory Commission (NRC), and the Department of Defense) with safeguards responsibility for these programs.

Because NRC has primary responsibility for commercial nuclear facilities, it has been the focus of this report. The NRC safeguards tasks can be considered in four classes; the first three are of present concern but the fourth allows time for further study.

1. Protection of Shipments of Privately Owned Strategic Nuclear Material.—NRC requirements on shipments of strategically significant amounts of special nuclear material (i.e., 5 kg or more of highly enriched U^{235} or 2 kg or more of plutonium or U^{233}) are currently less stringent than those recently adopted by ERDA for shipment of its own material. One critical element of effective safeguards is secure communication during transportation. ERDA has such a system (SECOM), but its use is at present restricted to transport of ERDA material. There appear to be no serious legal, economic, or institutional reasons why shippers of privately owned nuclear material cannot employ the ERDA communications and control system. Transportation security for NRC licensees would be further upgraded by the use of specially designed, penetration resistant tractor-trailers similar in performance to ERDA's and accompanied by escort vehicles.

2. Protection of Production Facilities That Possess Strategic Special Nuclear Materials.—NRC sets requirements to protect those privately owned facilities licensed for possession of strategic quantities of plutonium or highly enriched uranium. NRC also inspects the facilities to ensure license compliance to its regulations. Controversy over whether or not safeguards are presently adequate at these facilities centers around what level of threat safeguards should meet. Although this report has not assessed safeguards at specific facilities, it can make some observations about the methods of assessment now being used.

In current assessments, more attention has been given to the size of a potential nonstate adversary group than to any other single attribute. Although some historical data on size of threats are useful as a guide, an estimate of the numbers of attackers is inescapably a matter of judgment. A study in progress at the Rand Corp. suggests a range of anywhere from 7 or 8 to about 15 attackers as a prudent estimate, without speaking in terms of a maximum threat. NRC has reportedly ordered its licensees to upgrade physical security to meet a threat of two or more insiders acting in collusion with several heavily armed attackers from the outside.

In addition to numbers, other important parameters to consider are armament, tactics, and the characteristics of the facility itself. Present safeguards and physical security may place undue reliance on one element of physical security—armed guards. It is not clear how well presently designed safeguard systems can handle the problem of several insiders acting in collusion, or outsiders attacking with guile and deception rather than straightforward armed assault.

Moreover, guards at nuclear facilities presently have only civilian arrest powers, which are quite limited and vary from State to State. Serious consideration should be given to ways to clarify the power of the guards. The question of using a Federal security force to protect nuclear material needs reopening, particularly in light of the increased threat levels licensees are being required to meet.

It should also be recognized that there could be an alternative to reliance on onsite guards for standoff of an armed attack. A crucial question, which deserves serious review, is the extent to which safeguards systems can be designed to sufficiently **delay** attacking adversaries so that the burden of engagement and arrest falls on offsite response forces rather than onsite guards.

3. Protection of Power Reactors Against Sabotage.—The question of reactor sabotage was judged peripheral to the main focus of this study: the proliferation of nuclear weapons. The report has therefore not assessed the adequacy of U.S. domestic security at power reactors.

4. Protection of Future Facilities That Would Process Plutonium-Containing Fuel or Other Concentrated Weapons Material.—It is not clear whether NRC will decide to license plutonium processing facilities, or if so, when. The only such plant which could start operations within the next few years is the Allied-General Nuclear Services spent-fuel reprocessing plant at Barnwell, S.C. Other facilities to produce plutonium oxide or to fabricate plutonium for breeder reactors exist only on paper and are 5 to 10 years from completion.

Several safeguard concepts have been put forth in recent years to meet the problems posed by large-scale concentrated weapons material in processing and fabrication facilities. These are listed and briefly assessed below:

- **Massive Spiking.**—Massive spiking is the addition of lethal amounts of radioactive material to fresh fuel as a barrier to theft. Studies indicate that this technique is not cost effective compared to massive containment and stringent physical security for domestic safeguards use. Massive spiking would not be useful at all in restraint of national proliferation.
- **Light Spiking.**—Spiking of highly enriched uranium with low levels of radioactive material should be given further study.
- **Denaturing of Plutonium.**—The concept of denatured plutonium—plutonium which, because of its isotopic composition, is not suitable for explosives—is fallacious.
- **Storage and Transport of Plutonium in Dilute Mixed-Oxide Form.**—If plutonium dioxide were always mixed with a large quantity of uranium oxide, when stored and transported, its usefulness to the nonstate adversary would be considerably reduced. A group would have to steal large amounts of mixed-oxide material and undertake time-consuming chemistry to separate the plutonium. However, the dilute mixed-oxide form would constitute much less of a barrier against national diversion.
- **Colocation of Reprocessing and Fuel Fabrication Plants.**—The colocation of reprocessing plants and mixed-oxide fuel fabrication plants would eliminate the transport of pure plutonium oxide. The advantages and disadvantages of this safeguard measure have not yet been assessed in any systematic way. However, if coprecipitation is employed at the reprocessing plant so that its output is dilute plutonium oxide in uranium oxide, colocation would probably not offer significant additional safeguard advantages.
- **Advanced Materials Accounting System.**—No substantial economical improvement in the sensitivity of materials accountancy can be expected unless real-time material control can be implemented. Two such systems are being developed: SYMAC at Los Alamos Scientific Laboratory and RETIMAC by NRC at Lawrence Livermore Laboratory. Considerable development work and in-plant demonstration is required before the effectiveness and costs of real-time material control can be reliably assessed. However, even once developed, such systems. could not do the entire safeguards job. Physical security, containment, and surveillance will still play crucial roles in both domestic and international systems.
- **Integrated Safeguard Systems.**—The most effective safeguard systems would be those in which the various elements are integrated with one another and into the design of new facilities. Such systems demand not only development of hardware and computerized control but, also, development of methodologies to assess their effective-

ness against both outside attack and embezzlement by insiders. The input to this assessment must be reliable data on the individual elements of the system. It is therefore important to continue experimental programs to provide information on the penetration resistance of barriers, the reliability of alarms, and the efficacy and safety of techniques such as foams and reactive sensors that delay and confuse the adversary.

IAEA SAFEGUARDS

The objective of the IAEA safeguards systems is to detect national diversion. Materials accountancy is considered to be the safeguards measure of fundamental importance by IAEA. Containment and surveillance are regarded as important complementary measures.

The materials accountancy system is based on records and physical inventories made by the facility operator and subsequently verified by the IAEA inspector. Containment is the use of physical barriers to restrict and control access to or movement of nuclear materials. Surveillance means instrumental or human observation to detect access to or movement of nuclear material. It is generally accepted that there are unavoidable limitations on material accountancy due to measurement errors: containment and surveillance will therefore have to be assigned much greater importance in the design of safeguards.

The role of IAEA in the issue of physical security is an advisory one. Physical security systems are the prerogative of the individual nation. As part of an effort to upgrade physical security worldwide, ERDA physical-security review teams visited a large number of countries in 1975-76. The result of the visits are classified by ERDA because of the classified nature of physical security measures in foreign states: ERDA further stated that laws, regulations, and factors peculiar to each nation made it difficult to draw even general observations about the visits.

IAEA Safeguarding of Power Reactors.—It is difficult to evaluate the present effectiveness of IAEA safeguards on power reactors because information about critical IAEA procedures and policies is either not available outside the Agency or is classified by IAEA as "safeguards confidential." Some of this information may become available in the Director General's proposed special safeguards "Implementation Report to the Board of Governors." The report was expected in September 1977, after several delays totaling over a year.

On the basis of the available information, it appears credible that IAEA will develop and implement improved equipment and techniques to make undetected diversion from light water reactors or their spent fuel storage pools very unlikely. Safeguarding onload reactors, such as the CANDU which is refueled without being shut down, is substantially more difficult.

A great deal of research is being done on surveillance and containment to safeguard CANDU reactors, but not enough information is available at present for a reliable assessment. IAEA may decide to request the right to station resident inspectors at these reactors. Such a move would greatly increase IAEA costs and workload.

IAEA Safeguarding of Enrichment and Reprocessing Plants.—To date, IAEA has not safeguarded any type of enrichment plant (including pilot plant), nor has it undertaken the routine application of safeguards on a long-term basis to any commercial reprocessing plant.

As now proposed, IAEA inspection procedures for enrichment plants (especially centrifuge plants) leave open a path for a nation to obtain highly enriched uranium for weapons. The Nation might convert one section of its centrifuge plant to a high enrichment loop. Detection of this loop would be difficult: the IAEA inspector is currently denied access to the cascade area (that is, the area where the actual enrichment takes place), and is not allowed to monitor any new equipment that goes in and out of this area. Reconfiguration of the plant would have to be deduced from measurements of other inputs and outputs to the cascade area. Furthermore, materials accounting is currently not accurate enough for a large plant to assure the inspector that a significant diversion has not taken place. Despite objections that permitting IAEA inspectors inside the cascade area will expose commercial secrets, doing so would greatly enhance the effectiveness and credibility of IAEA inspection.

Present material accounting systems (both United States and IAEA) for use in large commercial reprocessing plants are not sensitive enough to reliably detect diversion of the order of tens of kilograms of plutonium. More importantly, detection may occur weeks or months after the diversion. IAEA requires materials accountancy to be supplemented by containment and surveillance measures. Advanced containment and surveillance systems are currently in the conceptual design stage. The aim is to develop systems that will be effective and reliable, indicate attempts to tamper, and eventually be able to report in real time to both a central inspector station and IAEA headquarters in Vienna. Such systems are essential to the credibility of IAEA safeguards on reprocessing plants.

IAEA will not be immediately confronted with the safeguarding of very large enrichment or reprocessing plants. Given adequate manpower, and technical and financial support, the safeguards system should be able to improve as the size of facilities under safeguards increases. It is not, however, possible to conclude at this time that this effort will be successful. There are a number of unresolved technical and political problems, any one of which might preclude truly credible safeguards against covert diversion for these types of plants.

International Institutions, Agreements, and Sanctions

Safeguards on nuclear facilities can be only as strong as the agencies that apply them, and only as effective as the responeses that enforce them. The entire climate for international safeguards is governed largely by the institutions and agreements that are described.

APPENDIX A

Congressional Research Service
The Library of Congress

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NUCLEAR SAFEGUARDS: SELECTED REFERENCES

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INTRODUCTION

This bibliography lists selected citations to materials on nuclear safeguards, focusing on those administered by the International Atomic Energy Agency and on related U.S. policy and support for them.

Citations listed in the bibliography were selected from the CRS Bibliographic Data Base, the Library of Congress Computerized Catalog, the Department of Energy's RECON Data Base, and the NTIS Data Base. Library of Congress call numbers have been provided when available. The designation law indicates materials that are held in the Library of Congress Law Library. Publications available from NTIS may be examined on microfiche in the Library of Congress Science Reading Room (LA-5008).

Acronyms used in the bibliography

ERDA	Energy Research and Development Administration
IAEA	International Atomic Energy Agency
INFCE	International Nuclear Fuel Cycle Evaluation
LMFBR	Liquid metal fast breeder reactor
NDA	Non destructive analysis
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRC	Nuclear Regulatory Commission

Nuclear Safeguards: Selected References

Ayers, A. L., and L. D. Barnes. Development of an advanced safeguards system as a proliferation deterrent. Transactions of the American Nuclear Society, v. 30, 1978: 296-297. QC770.A47, v. 30

Baldonado, O. C., and others. Safeguards systems concepts for nuclear material transportation; final report. [Washington, U.S. Nuclear Regulatory Commission, available from NTIS] 1977. 2 v.
"NUREG-0334" and NUREG-0335"

Bambas, K. J. Potential for meeting IAEA safeguards goals for reprocessing. In International Executive Conference on Nonproliferation and Safeguards, Mexico City, 1980. Barnswell, S.C., Allied-General Nuclear Services [available from NTIS] 1980. 12 p.
"AGNS-35900-CONF-85"

Barkenbus, J. N. International acceptability of advanced safeguarding techniques. Oak Ridge, Tenn., Oak Ridge Associated Universities, Institute for Energy Analysis [available from NTIS] 1979. 60 p.
"ORAU/IEA-79-18(R)"

Bartels, W. C. U.S. technical assistance to IAEA safeguards. In Transactions of the American Nuclear Society, v. 30, 1978: 347-348.
QC770.A47, v. 30

Bennett, C. A., and others. A review of the application of strategic analysis to material accounting; a consensus report. Argonne, Ill., Argonne National Laboratory [available from NTIS] 1979. 70 p.
"NUREG/CR-0950"

Bennett, Carl A., William M. Murphey, and Theodore S. Sherr. Societal risk approach to safeguards design & evaluation. [Washington, U.S. Energy Research and Development Administration] 1975. 58 p.
"ERDA-7"

Blakeman, E. D. Safeguards against proliferation of nuclear materials: a review and bibliography. Oak Ridge, Tenn., Oak Ridge National Laboratory, Nuclear Safety Information Center [available from NTIS] 1980. 153 p.
"NUREG/CR-1146"

Brewer, Thomas L. Nuclear energy forecasts and the international safeguards system. Technological forecasting and social change, v. 11, no. 1, 1977: 9-23.

Cobb, D. D., and others. Development and demonstration of near-real-time accounting systems for reprocessing plants. Los Alamos, N.M., Los Alamos National Laboratory [available from NTIS] 1981. 12 p.
"CONF-810706-29"

Coleman, Jerry Peter. International safeguards against non-government nuclear theft: a study of legal inadequacies. International lawyer, v. 10, summer 1976: 493-513. JX1.I63, v. 10

Conference on Nuclear Safeguards, Orlando, Florida, 1976. Program report. Washington, Atomic Industrial Forum [1976]. 1 v. (various pagings)

Deitrich, J. R. Safeguarding the nuclear fuel cycle. Nuclear engineering international, v. 22, Nov. 1977: 57-61.

Demuh, A. N. Dymac accountability system. Transactions of the American Nuclear Society, v. 34, 1980: 167-168. QC770.A47, v. 34

Dickeman, R. L. Safeguards perspectives: an expression of industry's responsibilities and views. Nuclear materials management, v. 5, summer 1976: 42-46.

Donnelly, Warren H., and Allan M. Labowitz. The International Atomic Energy Agency: application of safeguards in the United States; an analysis of the agreement and an assessment of the negotiation prepared for the Committee on Foreign Relations, United States Senate by the Environment and Natural Resources Policy Division, Library of Congress. Washington, U.S. Govt. Print. Off., 1979. 91 p.
At head of title: 96th Cong., 1st sess. Committee print.

Egen, Gregg M. A study of nuclear safeguards under the International Atomic Energy Agency. [Washington] Atomic Industrial Forum, 1976. 32 p.

Eklund, S. Confidence in nuclear safety and non-proliferation of nuclear weapons: a prerequisite for further development of nuclear power. In Nondestructive evaluation in the nuclear industry: proceedings of an international conference, 13-15 February 1978, Salt Lake City, Utah. Sponsored by the Materials Testing and Quality Control Division of the American Society for Metals ... et al. R. Natesh, editor. Metals Park, Ohio, The Society, 1978. p. 1-13. TA417.2.N66

Fischer, D. A. V. Safeguards under the Non-Proliferation Treaty. Disarmament, v. 3, July 1980: 35-39. JX1974.D48, v. 3

Goldschmidt, Bertrand. A historical survey of nonproliferation policies. International security, v. 2, summer 1977: 69-87. JX1901.I67, v. 2

Green, L., H. Kouts, and W. Marcuse. IAEA costs and manpower requirements under NPT. Upton, N.Y., Brookhaven National Laboratory [available from NTIS] 1970. 34 p.
"BNL 50263 (T-593)"

Green, Leon. Technical assistance to IAEA safeguards. Nuclear materials management, v. 8, proceedings issue, 1979: 382-390.
Paper presented at the 20th annual meeting of the Institute of Nuclear Material Management, Albuquerque, N.M., 1979.

Greenhalgh, Geoffrey. Nuclear safeguards and non-proliferation. In his The necessity for nuclear power. [London] Graham & Trotman [1980] p. 210-220.

Grumm, H. IAEA safeguards--where do we stand today? International Atomic Energy Agency bulletin, v. 21, Aug. 1979: 32-39. QC770.I493 v. 21

Gummett, Philip. From NPT to INFCE: developments in thinking about nuclear non-proliferation. International affairs (London), v. 57, autumn 1981: 549-567.

Hakkila, E. A. Materials management in an internationally safeguarded fuels reprocessing plant, by E. A. Hakkila and others. Los Alamos, N.M., Los Alamos Scientific Laboratory [available from NTIS] 1980. 3 v.
"LA-8042"

----- Role of materials accounting in integrated safeguards systems for reprocessing plants, by E. A. Hakkila and others. Los Alamos, N.M., Los Alamos Scientific Laboratory, 1981. 7 p.
"LA-UR-81-1368"
Paper presented at the Symposium on Safeguards and Nuclear Material Management, Karlsruhe, Federal Republic of Germany, 1981.

Hatcher, C. R. U.S. development of NDA instruments for IAEA. Transactions of the American Nuclear Society, v. 30, 1978: 348-349. QC770.A47, v. 30

Haynal, G. Canadian safeguards policies. In International Symposium on Uranium Supply and Demand, London, 1977. Uranium supply and demand: proceedings of an international symposium held by the Uranium Institute in London, June 22, 1977. London, Mining Journal Books, 1977. p. 81-86.

Higinbotham, W. A. Safeguards technology. In Nuclear energy and nuclear weapon proliferation. Sponsored by Stockholm International Peace Research Institute. London, Taylor & Francis; New York, Distributed in U.S.A. by Crane, Russak, 1979. p. 187-197. TK9006.N75

Houck, Frank S. IAEA safeguards from a United States perspective. Nuclear materials management, v. 8, proceedings issue, 1979: 391-397.
Paper presented at the 20th annual meeting of the Institute of Nuclear Materials Management, Albuquerque, N.M., 1979.

Imai, Ryukichi. Safeguards--a new approach. Nuclear engineering international, v. 24, Apr. 1979: 53-56. TK9001.N75, v. 24

International Atomic Energy Agency. IAEA contribution to INFCE; the present status of IAEA safeguards on nuclear fuel cycle facilities. [Vienna] 1979. 64 p.
"INFCE/SEC/11"

----- IAEA safeguards: an introduction. Vienna, 1981. 38 p.

----- IAEA safeguards glossary. Vienna, 1980. 88 p. TK9009.I57 1980

----- Non-proliferation and international safeguards. Vienna, 1978. 76 p.
"Prepared in connection with United Nations special session of General Assembly devoted to disarmament, 23 May to 28 June 1978."

----- A short history of non-proliferation. Vienna, 1976. 50 p.
JX1974.7.I583 1976

International Nuclear Fuel Cycle Evaluation.

Working Group Reports

----- Assurances of long-term supply of technology, fuel and heavy water and services in the interest of national needs consistent with non-proliferation; report of Working Group 3. Vienna, International Atomic Energy Agency [New York, sold by UNIPUB] 1980. 101 p. TK9360.I64 1980, v. 3
"INFCE/PC/2/3"

----- Enrichment availability; report of Working Group 2. Vienna, International Atomic Energy Agency [New York, sold by UNIPUB] 1980. 155 p. TK9360.I64 1980, v. 2

----- Fast breeders; report of Working Group 5. Vienna, International Atomic Energy Agency [New York, sold by UNIPUB] 1980. 217 p.
TK9360.I64 1980, v. 5

----- The present status of IAEA safeguards in nuclear fuel cycle facilities; report of Working Group 4. Vienna, International Atomic Energy Agency [New York, sold by UNIPUB; available from NTIS] 1978. 57 p.
TK9360.I64 1980, v. 4
"INFCE/DEP/WG-4/115"

----- Reprocessing, plutonium handling, recycle; report of Working Group 4. Vienna, International Atomic Energy Agency [New York, sold by UNIPUB] 1980. 300 p. TK9360.I64 1980, v. 4
"INFCE/PC/2/4"

----- Spent fuel management; report of Working Group 6. Vienna, International Atomic Energy Agency [New York, sold by UNIPUB] 1980. 113 p.
TK9360.I64 1980, v. 6

Working Papers

----- International plutonium policy. [Vienna, International Atomic Energy Agency, available from NTIS] 1978. 8 p.
"INFCE/DEP/WG-4/107"

----- Proliferation resistance assessment of nuclear systems. [Vienna, International Atomic Energy Agency, available from NTIS] 1978. 47 p.
"INFCE/DEP/WG-8/91"

----- Safeguarding a future industrial reprocessing plant. [Vienna, International Atomic Energy Agency, available from NTIS] 1978. 15 p.
"INFCE/DEP/WG-4/118"

----- Safeguarding future large-scale plutonium bulk handling facilities; report to Working Group 4. Vienna, International Atomic Energy Agency [available from NTIS] 1979. 23 p.
"INFCE/DEP/WG-4/117"

International nuclear safeguards. International Atomic Energy Agency bulletin, v. 19, Oct. 1977: 2-22, 24-38, 40-44, 47. QC770.I493, v. 19

Jennekens, J. International safeguards: the quantification issue. International Atomic Energy Agency bulletin, v. 22, Aug. 1980: 41-44. QC770.I493, v. 22

Johnson, Brian. Nuclear power proliferation: problems of international control. Energy policy, v. 5, Sept. 1977: 179-194.

Kapur, Ashok. International nuclear proliferation: multilateral diplomacy and regional aspects. New York, Praeger, 1979. 387 p. JX1974.73.K36

Keepin, G. Robert. Safeguards implementation in the nuclear fuel cycle. Nuclear materials management, v. 7, fall 1978: 44-58.

Kennedy, R. T., and H. E. Lyon. Assurance of the effectiveness of safeguards in light of their objectives. Vienna, International Atomic Energy Agency, [available from NTIS] 1977. 14 p.
"IAEA-CN-36/414"
Presented at the International Conference on Nuclear Power and Its Fuel Cycles, Salzburg, Austria, 1977.

Kovan, Dick. Safeguarding a plutonium industry. Nuclear engineering international, v. 23, Aug. 1978: 41-45. TK9001.N75, v. 23

Kratzer, Myron B. International safeguards for reprocessing plants; final report, by M. Kratzer and others. Washington, International Energy Associates, 1981. 157 p.
"ORNL/SUB-7605/12-1"

----- International safeguards for spent fuel storage, by M. Kratzer and others. Oak Ridge, Tenn., Oak Ridge National Laboratory [available from NTIS] 1981. 73 p.
"ORNL/SUB-7605/12-2"

----- Nuclear cooperation and non-proliferation. Atomic energy law journal, v. 17, winter 1976: 250-288. LAW

Lovett, J. E. Development of the safeguards approach for reprocessing plants, by J. E. Lovett and T. Shea. In Symposium on Nuclear Material Safeguards, Vienna, 1978. Nuclear safeguards technology 1978: proceedings. Vol. 2. Vienna, International Atomic Energy Agency, 1979. p. 583-592. TK9153.S935 1978, v. 2

----- Nuclear materials: accountability, management, safeguards, by James E. Lovett. Hinsdale, Ill., American Nuclear Society, 1974. 298 p. TK9400.L65

Management of nuclear materials. Ralph F. Lumb, editor. Princeton, N.J., Van Nostrand, 1960. 516 p. HD9698.U52L8
"Prepared under auspices of the Office of Technical Information, United States Atomic Energy Commission.'

Marshall, W. To judge the degree of proliferation resistance, by W. Marshall and S. Tamiya. Vienna, International Nuclear Fuel Cycle Evaluation [available from NTIS] 1978. 40 p.
"INFCE/DEP/WG-4/104"

----- Politics, plutonium, and energy interdependence. Electric perspectives, v. 1980, fall 1980: 1-13. HD9685.U4E38, v. 1980

McKnight, Allan D. Atomic safeguards; a study in international verification. New York, United Nations Institute for Training and Research, 1971. 301 p. JX1974.7.M225

Miller, M. M. Heavy water and nonproliferation. Cambridge, Massachusetts Institute of Technology, Dept. of Nuclear Engineering [available from NTIS] 1980. 179 p.
"DOE/ET/33007-6"

Moglewer, Sidney. IAEA safeguards and non-proliferation. Bulletin of the atomic scientists, v. 37, Oct. 1981: 24-36. TK9145.A84, v. 37

Non-proliferation and safeguards. In International Atomic Energy Agency. Regional nuclear fuel cycle centres. Vol. 2. Vienna, 1977. p. 11-27. TK9360.I59 1977

Nonproliferation and U.S. foreign policy. Joseph A. Yager, editor. Washington, Brookings Institution, 1980. 438 p. JX1974.73.N66

Nuclear nonproliferation: the spent fuel problem. Frederick C. Williams and David A. Deese, editors. New York, Pergamon Press, 1979. 221 p. (Pergamon policy studies on energy and environment) TD899.A8N8 1979
Pergamon policy studies, no. 32.

Nye, J. S. Maintaining a non-proliferation regime. International organization, v. 35, winter 1981: 15-38. JX1901.F6, v. 35

Parker, L. International safeguards against the diversion of nuclear materials to non-peaceful uses. International and comparative law quarterly, v. 27, Oct. 1978: 711-737. LAW

----- Psychology of nuclear safeguards, by Lyn Parker. New scientist, v. 79, Aug. 17, 1978: 460-461.

Pendley, Robert, and Lawrence Scheinman. International safeguarding as institutionalized collective behavior. International organization, v. 29, summer 1975: 586-616. JX1901.F6, v. 29

Persiani, P. J. Preliminary considerations on developing IAEA technical safeguards for LMFBR power systems. Argonne, Ill., Argonne National Laboratory [available from NTIS] 1980. 77 p.
"ANL-80-69"

Pigford, T. H., C. S. Yang, and M. Maeda. Denatured fuel cycles for international safeguards. Nuclear technology, v. 41, Nov. 1978: 46-59.

Poch, L. A., and T. D. Wolsko. Review of the nuclear safeguards problem. Argonne, Ill., Argonne National Laboratory [available from NTIS] 1979. 20 p.
"ANL/EES-TM--67"

Present status of IAEA's safeguards on nuclear fuel cycle facilities. International Atomic Energy Agency bulletin, v. 22, Aug. 1980: 2-40.
QC770.I493, v. 22

Rainer, R., and B. Sanders. IAEA's NPT safeguards: national control and international safeguards. In Nuclear proliferation problems. Cambridge, Mass., MIT Press, 1974. p. 133-141. JX1974.7.N82 1974

Rappoport, L., and J. D. Pettinelli. Social psychological studies of the safeguards problem. Manhattan, Kan., Kansas State University [available from NTIS] 1972. 34 p.
"PB-81-112856"

Reynolds, D. A. Concepts on integration of physical protection and material accounting functions in a safeguards systems. Albuquerque, N.M., Sandia National Laboratories [available from NTIS] 1981. 5 p.
"CONF-810706--20"

Rochlin, Gene I. Safeguards, security, and the spread of nuclear weapons. In his Plutonium, power, and politics: international arrangements for disposition of spent nuclear fuel. Berkeley, University of California Press, 1979. p. 131-157. (Science, technology, and the changing world order)
HD9698.A2R59

Rometsch, R. IAEA's activities in safeguarding nuclear materials and in developing internationally acceptable safety codes and guides for nuclear power plants, by R. Rometsch and H. Specter. Transactions of the American Nuclear Society, v. 25, supp. no. 1, 1977: 40. QC770.A47, v. 25

----- International safeguards on the peaceful uses of nuclear material. Nuclear law, no. 13, Apr. 1974: 66-72. LAW

Rotblat, J. Controlling weapons-grade fissile material. Bulletin of the atomic scientists, v. 33, June 1977: 37-43. TK9145.A85, v. 33

Rowen, H. S. Nonproliferation criteria for assessing civilian nuclear technologies. In Sachs, R.G., editor. National energy issues: how do we decide? Plutonium as a test case. Cambridge, Mass., Ballinger, 1980. p. 179-193. HD9502.U52N35

Safeguarding the atom: a Soviet-American exchange. New York, United Nations Association of the United States of America, 1972. 71 p.

Sanders, B. International safeguards and the nuclear proliferation regime, by B. Sanders and R. H. Rainer. Transactions of the American Nuclear Society, v. 27, 1977: 491. QC770.A47, v. 27

----- International safeguards, by B. Sanders and Ha Vinh Phuong. Nuclear law bulletin, no. 18, 1976: 54-66.

----- Safeguards agreements--their legal and conceptual basis, by B. Sanders and R. H. Rainer. In International Conference on Nuclear Power and Its Fuel Cycle, Salzburg, Austria, 1977. Nuclear power and its fuel cycle: proceedings of an International Conference on Nuclear Power and its Fuel Cycle held by the International Atomic Energy Agency in Salzburg, May 2-13, 1977. Vienna, IAEA [New York, sold by UNIPUB] 1977. v. 7. p. 395-410. (International Atomic Energy Agency. Proceedings series)
TK9006.I4763 1977

----- Safeguards against nuclear proliferation, by Benjamin Sanders. Cambridge, Mass., MIT Press, 1975. 114 p. JX1974.7.S214

Scheinman, Lawrence. Nuclear development and international safeguards: where do we stand and where are we going? Nuclear materials management, v. 8, proceedings issue, 1979: 14-22.
Paper presented at the 20th annual meeting of the Institute of Nuclear Materials Management, Albuquerque, N.M., 1979.

Schleicher, H. W. Nuclear safeguards in the European Community: a regional approach. International Atomic Energy Agency bulletin, v. 22, Aug. 1980: 45-50. QC770.I493, v. 22

Sellers, T. A. Preliminary concepts for detecting diversion of light-water reactor spent fuel. In Symposium on Nuclear Material Safeguards, Vienna, 1978. Nuclear safeguards technology 1978: proceedings. Vol. 2. Vienna, International Atomic Energy Agency, 1979. p. 565-578.
TK9153.S935 1978, v. 2

Shipley, James P. The structure of safeguards systems. Los Alamos, N.M., Los Alamos Scientific Laboratory [available from NTIS] 1978. 20 p.
"LA-7337-MS"

Smart, Ian. Non-proliferation policies; a possible future framework. In Uranium and nuclear energy: proceedings of the fourth international symposium held by the Uranium Institute, London, September 10-12, 1979. Edited and published by Mining Journal Books Limited in co-operation with the Uranium Institute. London, Mining Journal Books, 1980. p. 268-289.
TN490.U7U7

Stanford, Joseph S. Nuclear assistance and cooperation agreements: some problems in the application of safeguards. Journal of international law and economics, v. 10, Aug.-Dec. 1975: 437-451. LAW

Stencel, Sandra. Nuclear safeguards. [Washington] Editorial Research Reports, 1974. 867-884 p. (Editorial research reports, 1974, v. 2, no. 19)
HE35.E35 1974, v. 2

Stockholm International Peace Research Institute. The NPT: the main political barrier to nuclear weapon proliferation. London, Taylor & Francis, 1980. 66 p. JX1974.73.S76 1980a

Sweet, William. Controlling nuclear proliferation. Washington, Congressional Quarterly, 1981. 511-531 p. (Editorial research reports, 1981, v. 2, no. 2) H35.E35 1982, v. 2

Symposium on Progress in Safeguards Techniques, Karlsruhe, 1970. Safeguards techniques. Proceedings of a symposium . . . organized by the International Atomic Energy Agency and held in Karlsruhe, July 6-10, 1970. Vienna, International Atomic Energy Agency, 1970. 2 v. (International Atomic Energy Agency. Proceedings series) TK9360.S817 1970

Symposium on the Safeguarding of Nuclear Materials, Vienna, 1975. Safeguarding nuclear materials: proceedings of a Symposium on the Safeguarding of Nuclear Materials organized by the International Atomic Energy Agency and held in Vienna, Oct. 20-24, 1975. Vienna, The Agency; New York, Sold by Unipub, 1976. 2 v. (International Atomic Energy Agency. Proceedings series) HD9698.A2S945 1975

Szasz, Paul C. The adequacy of international nuclear safeguards. Journal of international law and economics, v. 10, Aug.-Dec. 1975: 423-436. LAW

The Technical objectives of safeguards. International Atomic Energy Agency bulletin, v. 17, Apr. 1975: 13-17. QC770.I493, v. 17

U.S. Atomic Energy Commission. Office of Safeguards and Materials Management. Safeguards paper from ANS/AIF winter meeting, Nov. 1968. Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off., 1970. 160 p.
"WASH-1149"

U.S. Congress. Office of Technology Assessment. Nuclear proliferation and safeguards. [Washington] 1977. 2 v. in 3. UF767.U52 1977

U.S. Congress. Senate. Committee on Foreign Relations. IAEA programs of safeguards. Hearing, 97th Cong., 1st sess. Dec. 2, 1981. Washington, U.S. Govt. Print. Off., 1982. 104 p.

----- IAEA Safeguards Agreement. Hearing, 96th Cong., 1st sess. June 22, 1979. Washington, U.S. Govt. Print. Off., 1979. 196 p. KF26.F6 1979u
"Ex. B, 95-2, Agreement with the International Atomic Energy Agency for the application of safeguards in the United States."

----- U.S.-IAEA Treaty; report on the U.S.-International Atomic Energy Agency Safeguards Treaty [to accompany Ex. B, 95-2]. Washington, U.S. Govt. Print. Off., 1980. 72 p. (96th Cong., 2d sess. Senate. Executive report no. 96-42)

U.S. Congress. Senate. Committee on Foreign Relations. Subcommittee on Arms Control, International Organizations and Security Agreements. Nonproliferation issues. Hearings, 94th Cong., 1st and 2d sess. Washington, U.S. Govt. Print. Off., 1977. 426 p. KF26.F628 1975a
Hearings held Mar. 19-Oct. 24, 1975; Feb. 23-Nov. 8, 1976.

U.S. Congress. Senate. Committee on Governmental Affairs. Subcommittee on Energy, Nuclear Proliferation and Federal Services. Office of Technology Assessment report on nuclear proliferation safeguards. Hearing, 95th Cong., 1st sess. Apr. 4, 1977. Washington, U.S. Govt. Print. Off., 1977. 83 p. KF26.G6728 1977

U.S. General Accounting Office. Alternative methods for funding U.S. support of International Atomic Energy Agency activities, Department of State and other Federal agencies; report of the Comptroller General of the United States. Washington, U.S. Govt. Print. Off., 1977. 50 p.
"ID-77-20, May 5, 1977"

----- Assessment of U.S. and international controls over the peaceful uses of nuclear energy; report to the Congress by the Comptroller General of the United States. [Washington] 1976. 131 p. JX1974.7.U56 1976
"ID 76-60, Sept. 14, 1976"

----- An evaluation of the Administration's proposed nuclear non-proliferation strategy; report to the Congress by the Comptroller General of the United States. [Washington] 1977. 70 p.
"ID-77-53, Oct. 4, 1977"

----- Nuclear fuel reprocessing and the problems of safeguarding against the spread of nuclear weapons; report to the Congress by the Comptroller General of the United States. [Washington] 1980. 65 p. HD9698.U52U55 1980
"EMD-80-38, Mar. 18, 1980"

----- The Nuclear Non-Proliferation Act of 1978 should be selectively modified; report to the Congress by the Comptroller General of the United States. [Washington] 1981. 226 p.
"OCG-81-2, May 21, 1981"

----- Role of the International Atomic Energy Agency in safeguarding nuclear material, Department of State, Energy Research and Development Administration; report to the Committee on International Relations, House of Representatives by the Comptroller General of the United States. [Washington] 1975. 44 p.
"ID-75-65, July 3, 1975"

U.S. Library of Congress. Congressional Research Service. Nuclear safeguards: an updated analysis of the concept of safeguards as a national and international institution; report prepared for the Subcommittee on Energy and Production of the Committee on Science and Technology, U.S. House of Representatives. Washington, U.S. Govt. Print. Off., 1980. 50 p.
"Serial VV" HD9698.U52U57 1980a
At head of title: Committee print.

U.S. Nuclear Regulatory Commission. Joint ERDA-NRC task force on safeguards; final report [by the] Nuclear Regulatory Commission and the Energy Research and Development Administration. Washington [Available from NTIS] 1976. 78 p.
"PB-263 365/9G1", "NUREG--0095", "ERDA--77-34"

----- Report of the Material Control and Material Accounting Task Force. Washington [available from NTIS] 1978. 5 v.
"NUREG-0450", "PB-280 328/6G1", "PB-280 329/4G1", "PB-280 331/0G1"

U.S. resident, 1977-1981 (Carter). Agreement with the International Atomic Energy Agency for the application of safeguards in the United States of America, with protocol; message. Washington, U.S. Govt. Print. Off., 1978. 33 p. (95th Cong., 2d sess. Senate. Executive B)

Uranium Institute. Bilateral agreements and the evolution of the international safeguards system. London, 1981. 15 p.

Von Baeckmann, A. The application of modern methods and techniques in safeguards operations. International Atomic Energy Agency bulletin, v. 23, Mar. 1981: 15-19. QC770.I493, v. 23

Warnecke, Steven J. Non-proliferation and INFCE: an interim assessment. Survival, v. 21, May-June 1979: 116-124. U162.S9, v. 21

Weiss, Leonard. Nuclear safeguards: a congressional perspective. Bulletin of the atomic scientists, v. 34, May 1978: 27-33. TK9145.A84, v. 34

Williams, Frederick, and others. The Nuclear Non-Proliferation Act of 1978. International security, v. 3, fall 1978: 44-66. JX1901.I67, v. 3

Willrich, Mason. International safeguards and nuclear industry, Mason Willrich, editor. Baltimore, Johns Hopkins University Press, 1973. 307 p. HD9698.A2W53

----- Nuclear theft: risks and safeguards; a report to the Energy Policy Project of the Ford Foundation, by Mason Willrich and Theodore B. Taylor. Cambridge, Mass., Ballinger, 1974. 252 p. HD9698.A2W54

Yager, Joseph A. International cooperation in nuclear energy. Washington, Brookings Institution, 1981. 226 p. HD9698.A2Y34

Yolken, H. T. Possibilities for international co-operation in standardizing measurement methods for nuclear safeguards. In Symposium on Nuclear Material Safeguards, Vienna, 1978. Nuclear safeguards technology 1978: proceedings. Vol. 2. Vienna, International Atomic Energy Agency, 1979. p. 243-249. TK9153.S935 1978, v. 2

Zebroski, E. L. Paths to a nuclear world with reliable safeguards. In Conference on Spent Fuel Policy and Its Implications; executive conference proceedings. La Grange Park, Ill., American Nuclear Society, 1978. p. 31-46. TK9360.E93 1978